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International Financial Markets

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International Financial Markets

A Dissertation

Submitted to the Graduate Faculty of the
University of New Orleans
In partial fulfillment of the
requirements for the degree of

Doctor of Philosophy
in
Financial Economics

by

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May, 2012

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Abstract

This dissertation consists of two essays: one looks at the cross-country variations in volume-price variability relationship and cultural and other country factors, and the other looks at cause and effects of large one-day price changes in commodity futures.

The first essay presented in Chapter 1 investigates the effect of cultural and other country factors on the dynamic relation between market-wide trading activity and price variability in 20 countries. The results show that individualism and masculinity are positively related to volume-variability relation; other country factors including information asymmetry, financial development, short sale and age distribution are also closely related to the volume-variability relation. Specifically, the return-variability relation is stronger in less financially-developed countries with short-sale constraints and high information asymmetry.

The second essay presented in Chapter 2 examines the causes and effects of large price changes in 26 commodity futures. The results indicate that announcements of macroeconomic news, the maturity effect, and the seasonal effect can explain the futures price movements of food (non-grains), grain, and livestock better than those of energy and metal. Without controlling for other factors, I find some support for the overreaction theory, especially following negative large price changes in closing. However, controlling for macro factors or market conditions, there is no support for overreactions.

Key Words: Cultural factors, trading volume, absolute price, large price changes, overreaction, maturity effect

Chapter 1

Cross-Country Variations in Volume-Price Variability Relationship and Cultural and Other Country Factors

1. Introduction

In recent years, a growing body of literature has shown cultural factors having effects on many financial decisions and strategies. Examples include momentum strategy and trading behavior (Chui, Titman and Wei, 2010), financial systems (Kwok and Tadesse, 2006), capital structure (Chui, Lloyd and Kwok, 2002; Li, Griffin, Yue and Zhao, 2011), protection of investor rights (Stulz and Williamson, 2003), mergers (Ahern, Daminelli and Fracassi, 2011) and dividend policy (Fidrmuc and Jacob, 2010; Shao, Kwok and Guedhami, 2010). Of particular interest here is the paper by Chui, Titman and Wei (2010), who find that the momentum effect in the stock market is stronger in countries with stronger degree of individualism. Their results imply that cultural factors affect trading behavior. It is hypothesized here that since cultural factors affect trading, they might also affect the relation between trading volume and price variability.

In addition, extant papers on the relation between volume and returns or absolute returns (e.g., Clark, 1973; Rogalski, 1978; Chordia, Huh, and Subrahmanyam, 2007) mainly focus on contemporaneous relationship or lagged relation in the short term (weeks 1 through 20) at stock market. The only long-term study is by Statman, Thorley and Vorkink (2006) that find the positive volume-returns relation dissipates after eight months by using the US monthly data over 1962-2002. No research has attempted to compare short-term and long-term relationship between trading volume and price variability across countries.

In this paper, I examine the relation between trading volume and price variability patterns at the market level in 20 countries[1] and whether cross-country variations in volume and price variability relation might be explained by cultural and other country factors. More specifically, in the first part, I examine the relationship between stock trading volume and variability in 20 countries. In the second part, I examine whether the volume-variability relation might vary with time horizons.[2] In the third part, I examine whether cultural factors and other cross-country factors may affect the volume-variability relationship.

Although there is a large body of literature on volume-variability relationship, cultural and other country factors have never been incorporated to account for such relationship. Hence, one contribution is to examine the effects of cultural and other country factors on the volume-variability relationship. Cultural dimensions developed by Hofstede (1997) include four indexes, namely, individualism index (IDV), masculinity index (MAS), uncertainty avoidance index (UAI), and power distance index (PDI). In particular, Chui, Titman and Wei (2010) argue that IDV is related to overconfidence and self-attribution bias. Moreover, people in individualistic culture are overoptimistic about their abilities, and they tend to overestimate the precision of their prediction. Hence, I expect individualism to be positively related to the relationship between absolute value of returns and volume. MAS refers to the distribution of roles between the genders, and it is suggested that in more masculine countries people are

[1] The countries are distributed over Oceania, South America, North America, Asia, and Europe.

[2] Statman, Thorley, and Vorkink (2006) conclude that the lead-lag relation between returns and volume is stronger in earlier periods in US stock market.

somewhat assertive and competitive and are more likely to take risk. Therefore, I expect that the relationship between absolute value of returns and volume to be more positive in countries with high MAS. PDI is "the extent to which the less powerful members of organizations and institutions accept and expect that power is distributed unequally". (Hofstede, 1997, p.28) A high PDI indicates that the less powerful members of the society are more willing to accept inequality of power and wealth. UAI reflects a society's tolerance for uncertainty and ambiguity. The combination of two high scores on these indexes UAI and PDI reflects a society that is more rule-oriented, less readily accepts changes, and less likely to take greater risks. Hence, I expect that for countries with higher UAI and PDI, the relationship between absolute value of returns and volume tends to be weaker. To verify the robustness of my findings, I also use GLOBE's cultural dimensions (House, Hanges, Javidan, Dorfman and Gupta (2004)) to further study on volume-variability relation.[3]

Second, I also incorporate other country factors (e.g., the degree of financial market development) that might be important in explaining the volume-price variability relation. Third, to my knowledge, this is the first paper that attempts to examine whether the volume-variability relationship depends on time horizons across countries.

The rest of the study is organized as follows. Section 2 describes the related literature. Sections 3 describes the data and section 4 provides the methodologies. In section 5 I present the empirical results. Section 6 concludes.

[3] See Appendix A for more information about GLOBE's cultural dimensions.

2.Literature Review

2.1 Empirical Evidence on Returns-Volume Relation

The empirical research on the stock price-volume relation in financial markets primarily focuses on two aspects: (1) the correlation between volume and price changes and (2) the correlation between volume and absolute value of price changes.

2.1.1 Volume-Price Changes Relation

Existing literatures show that there is on average a positive relation between returns and volume. For example, using monthly data from 10 stocks and 10 warrants, Rogalski (1978) finds a contemporaneous positive correlation between price changes and volume, but no lagged correlation. More recent empirical work has investigated the lagged relation between price changes and volume. For example, Chan and Tse (1993) show a positive correlation between price and volume through their residuals. Hiemstra and Jones (1994) find a significant positive correlation between returns and volume through the use of nonlinear Granger causality. Chordia, Roll and Subrahmanyam (2001) find negative past returns are positively related to dollar volume in the US market from 1988 through 1998. Griffin, Nardari and Stulz (2007) investigate the dynamic relation between market-wide trading activity and returns in 46 countries and report a strong positive relationship between turnover and past returns.

However, some papers report mixed results for the relation between volume and price changes. An early empirical examination on volume-price changes was conducted by Granger and Morgenstern (1963). Using spectral analysis on weekly index data and daily transactions of individual stock data on New York Stock Exchange, they conclude that prices and volume are virtually unrelated and that price changes follow a random-walk. Using daily, weekly, and monthly series of different indices in the Tokyo Stock Exchanges, Tse (1991) finds a significant positive relationship in some series and not in others; hence, he concludes that the relationship between price changes and volume in the market is weak. In addition, using daily data, Bhagat and Bhatia (1996) provide evidence that price changes lead volume, but no evidence that volume leads price changes.

In brief, although there are some exceptions about the positive relationship between price changes and volume, overall there seems to be more support for positive relationship between price changes and volume.

2.1.2 Volume-Absolute Price Changes Relation

Using daily and hourly price changes for both market indices and individual stocks, Crouch (1970) finds a positive correlation between volume and absolute value of returns. Using the daily price changes for 136 futures contracts, Rutledge (1984) finds a significant correlation between volume and absolute value of price changes for 113 futures contracts. Using daily transaction data, Wood, Mcinish, and Ord (1985) report a positive correlation between volume and the magnitude of price changes. Smirlock and Starks (1988) document a strong positive lagged relation between volume and absolute value of price changes at stock transaction level. Wang (1994) concludes that trading volume is positively correlated with absolute price changes and the correlation increases with information asymmetry. Using monthly index data, Saatcioglu and Starks (1998) show that investors are more likely to trade when price changes are large in absolute value.

In addition, there is a vast number of empirical evidence on relationship between volume and price volatility, which also reflects absolute price changes. Using daily data from the cotton futures markets, Clark (1973) finds a positive relation between the variance of price changes and aggregated volume. Morgan (1976) finds that the variance of price changes is positively related to trading volume by using four-day interval and monthly data from a total of 51 stocks. Cornell (1981) finds a positive relationship between changes in volume and changes in the variability of prices, each measured over two-month intervals, for each of 17 futures contracts. Using daily data from 479 common stocks, Harris (1983) finds a positive correlation between volume and the square of the price changes. Grammatikos and Saunders (1986) also find volume is positively correlated with price variability for foreign currency futures. Richardson, Sefeik and Thompson (1986) show that trading volume increases with variance of abnormal returns around announcements of dividend changes. Similar empirical evidence is document by Karpoff (1986, 1987), Gerety and Mulherin (1992), and Bessembinder, Chan, and Seguin (1996). Gallant, Rossi and Tauchen (1992) investigate the price and volume co-movement using daily data from 1928 to 1987 for New York Stock Exchange (NYSE) and find a positive relationship between conditional price volatility and stock volume. Chan and Fong (2000) find that trading volume for foreign stocks is strongly associated with NYSE opening price volatility.

2.2 Theoretical Explanations

Several theoretical explanations have been offered to explain empirical evidence on volume-price changes relation and volume-absolute price changes relation, respectively. For volume-absolute price changes, two explanations are offered. First, Copeland (1976, 1977), Morse (1980), Jennings, Starks, and Fellingham (1981), and Jennings and Barry (1983) develop and extend “sequential arrival of information” models where new information is disseminated sequentially to traders in the market, and traders not yet informed cannot rely on information to trade. Hence, the sequential arrival of information generates co-movement between trading volume and price changes. Consequently, trading volume is strongly associated with absolute value of price changes and that volume should increase during those time periods when price changes are serially correlated. Second, based on “mixture-of-distributions” hypothesis that daily price changes are uncorrelated and symmetrically distributed, Clark (1973), Epps and Epps (1976), Tauchen and Pitts (1983) and Harris (1983), derive a model in which volatility of price changes is conditioned on volume (Karpoff, 1987). For volume-price changes relation, one explanation is found in Epps (1976), who constructed a model that implies positive price changes induce higher volume than negative price changes. Based on the assumption of concept of “bear” and “bull” investors, he argues that “bulls” are more optimistic about the value of asset and they react only to good news, while “bears” only react to bad news. The demand curve only consists of the demand prices of “bulls”, while supply curve only consists of prices of “bears”. Therefore, the market demand curve is steeper than the supply curve. That is, positive price changes have a larger effect on volume than negative price changes.

2.3 Possible Factors for Cross-Country Variations in Volume-Variability Relation

Theoretical literature on the explanations of volume-variability relation suggests the following factors that might explain the volume-price variability relation across countries: information asymmetry, short sale, financial development, age distribution and cultural factors.

2.3.1 Information Asymmetry

Wang (1994) argues that information asymmetry among investors induces trading and trading is accompanied by price changes since investors are risk averse. When traders are informed with information or news that would depreciate stock prices in the near future, they tend to sell their stock shares, there must be a drop in stock prices that induces uninformed investors to buy. As information asymmetry increases, the uninformed investors will require a higher discount in stock prices to cover the risk of trading without knowing information. Conversely, when traders are informed with news that would appreciate stock prices, they would like to buy stock, there must be an increase in stock prices to induce uninformed traders to sell. Therefore, trading volume is positively correlated with the magnitude of price changes and the correlation increases with information asymmetry. Llorente, Michaely, Saar and Wang (2002) also document that trading volume and returns autocorrelation patterns in relation to information asymmetry due to the existence of private information. Therefore, I expect the positive volume-variability relationship to be stronger in countries with higher degree of information asymmetry.

2.3.2. Short Sale

Diamond and Verrecchia (1987) argue that when short sale is prohibited, adverse information is incorporated into prices at a slow speed. The model of Brennan and Cao (1997) suggests that volume-price relation should be weaker as information is incorporated into price at a quicker rate. Griffin, Nardari and Stulz (2007) conclude a significantly positive relationship between returns and volume in 16 out of 21 countries that do not allow short sale but only in 8 out of 25 countries that allow short sale. Hence, I expect the volume-variability relation to be stronger where short sale is costly.

2.3.3 Financial development

In less financially development countries, there might be more trading noise, a cause of volatility. Therefore, I expect the volume-variability relation to be stronger in less financially development countries.

2.3.4 Age Distribution

Bakshi and Chen (1994) argue that an investor's relative risk aversion increases with age. As people get older, they are more risk averse and less actively participating in trading activity, therefore, I expect the volume-variability relation to be weaker when the average age of population increases.

2.3.5 Cultural Factors

Chui, Titman and Wei (2010) find that people in individualistic cultures tend to be optimistic about their abilities, which is associated with overconfidence and self attribution. They provide evidence that individualism is positively associated with the trading volume. They also find positive relation between individualism and volatility. Daniel, Hirshleifer and Subrahmanyam (1998), Statman, Thorley, and Vorkink (2006), and Glaser and Weber (2009) suggest that overconfidence generates excess trading volume and volatility. Therefore, if investors are overconfident, there might be a stronger positive correlation between volume and price variability.

3. Data

3.1 Price Variability and Volume

To examine the relationship between volume and price variability through time and across countries, I use the daily and monthly data from January 2, 1993 through September 1, 2011.[4] From Yahoo Finance website and DataStream, I collect the daily and monthly market prices and trading volume of 20 countries in US currency. I calculate turnover by scaling the trading value by market capitalization, which can be retrieved from the World Bank database.[5]

3.2 Cultural Factors and Other Factors

I collect cultural dimensions including PDI, IDV, MAS and UAI for 20 countries from Hofstede (1997). I also incorporate other country variables that might be helpful in explaining the relation: (1) to measure the information asymmetry and information disclosure, I use the disclosure index of La Porta, Lopez-de-Silanes, and Shleifer (2006). In addition, the number of analysts and the precision of analyst forecast are obtained from Chang, Khanna, and Palepu (2000); (2) the short sale dummy variable is obtained from Bris, Goetzmann, and Zhu (2007); (3) to measure financial development, I use log of GDP per capita and market capitalization to GDP to proxy financial development. These two variables come from World Bank Data; (4) to

[4] Griffin, Nardari, and Stulz (2007) focus on 10.5 years from January 2, 1993 through June 30, 2003 to examine volume-returns relation.

[5] Lo and Wang (2000) argue in favor of using turnover over alternative measure of trading activity. Therefore, following Lo and Wang (2000), I scale the trading value by contemporaneous market value. Throughout the article, I use turnover but for convenience will often refer to it simply as volume.

measure age distribution, I use the weighted average age of population of persons 20 and older of each country[6], which is obtained from U.S. Census Bureau.

4.Methodology

4.1Estimating Volume-Variability Relation

Similar to the methodology of Statman, Thorley and Vorkink (2006), I estimate volume-absolute returns relation through time by using vector autoregressive (VAR) model on a country-by-country basis.[7] Here, absolute returns measure price variability. A large body of literature (e.g., Rogalski, 1978; Heimstra and Jones, 1994) suggests that there is a Granger Causality relation between price changes and volume; hence, VAR model can better capture volume-price variability relation.[8] Moreover, based on the VAR model, impulse response estimation can be performed to describe how volume reacts over time to price variability. The bivariate VAR model contains two endogenous variables, turnover and price variability, and is specified as follows:

$$\begin{vmatrix} Vol_t \\ abs(\mathrm{Re}t_t) \end{vmatrix} = \begin{vmatrix} \alpha_{vol} \\ \alpha_{abs(ret)} \end{vmatrix} + \sum_{p=1}^{p} A_p \begin{vmatrix} Vol_{t-p} \\ abs(\mathrm{Re}t_{t-p}) \end{vmatrix} + \begin{vmatrix} e_{vol,t} \\ e_{abs(ret),t} \end{vmatrix} \qquad (1)$$

[6] Persons under 20 may not play a role in economic decision making.

[7] Lucas (1976) points out it is naive to use a structural model to predict the effect of economic policy on the basis of historical data. This is the well-known Lucas Critique. Lucas (1976, p.41) writes, "Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision models."

[8] In this paper, I only look at the response of turnover to absolute return. Although I use VAR model as shown Eq. (1), I only report the impulse response of volume to absolute returns.

where *Vol* is log of turnover and abs(*Ret)* is absolute value of price changes, which is defined as $abs(\mathrm{Re}t_t) = \left|\frac{p_t - p_{t-1}}{p_{t-1}}\right|$ and p is stock price. The regression coefficients A_p estimate the relationship between turnover and price variability, where *p* is the number of lags.

To estimate Eq. (1), first, I use Akaike Information Criterion (AIC) and Schwarz' Bayesian Information Criterion (SIC/BIC/SBIC) and likelihood ratio test to identify the appropriate lags of variables. Then, I use augmented Dickey-Fuller (ADF) test to determine whether volume and price variability are stationary or not. If they are stationary, I estimate VAR model by using the ordinary least squares regression analysis. Since individual VAR coefficient estimates do not capture the full impact of an exogenous variable observation, I use the associated impulse response function to trace the full impact of a shock.

4.2 Cultural Factors and Other Cross-Country Variations

To examine how the volume-variability relation depends on the cultural and other factors, I form the following regression analysis based on Chui, Titman, and Wei (2010):

$$\begin{aligned} effect_{it} &= \alpha_1 + \theta Short_i + \vartheta Cap_{it} + \mu GDP_{it} + \rho Error_i + \pi Disclosure_i \\ &+ \phi Analysts_i + \gamma IDV_i + \delta MAS_i + \varphi PDI_i + \omega UAI_i + \xi Age_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

where $effect_{it}$ indicates the five-day response of volume to absolute value of returns in country i in year t. While explanatory variables $Short_i$ (short sale dummy), $Error_i$ (forecast error),

$Disclosure_i$ (disclosure), $Analysts_i$ (number of analysts), IDV_i , MAS_i , PDI_i ,and UAI_i are constant over time for each country i, the explanatory variables Cap_{it} (market capitalization/GDP), GDP_{it} (GDP per capita) and Age_{it} are updated annually for country i. To efficiently estimate the effects of cultural factors, I use random-effect procedure to estimate Eq. (2). I expect to see parameters θ , ϑ , μ , π , ϕ , φ , ω , and ξ to be significantly negative, which suggest those variables have a negative effect on the response of volume to absolute value of returns. I also expect to see parameters ρ , γ , and δ to be significantly positive which imply that those factors are positively correlated with the impact of absolute value of returns on volume.

5. Empirical Evidence

5.1 Summary Statistics

Table 1 presents summary statistics for daily absolute returns, volatility, and turnover. Using World Bank classification, I separate my sample into high-income countries and developing countries according to national income (GNI) per capita. Panel A summarizes results for high-income countries, and Panel B summarizes results for developing countries.

Panel A indicates that in high-income countries, volatility varies across countries. New Zealand has the lowest volatility, while France, Hong Kong, Netherland and UK have volatility roughly twice greater than Australia, Switzerland and US. Turnover in Netherland and US is over 0.3 per cent per day, meaning that over 0.3 percent of the outstanding shares are traded in a given day. However, Australia, Belgium, France, Hong Kong, Japan, New Zealand, Singapore and Switzerland all have turnover of less than 0.1 per cent per day. Developing markets are

Table 1 Summary Statistics (Daily Data)

For each country, I report the mean (μ) for daily absolute returns, volatility, and turnover. Units are percent per day. Panel A summarizes result for high-income markets, whereas panel B summarizes results for developing countries.

	Abs(Return)	Volatility	Turnover
Country	μ(%)	μ (%)	μ(%)
Panel A: High-income country			
Australia	0.0228	0.0074	0.0872
Belgium	0.0212	0.0133	0.0869
Canada	0.0187	0.0099	0.1311
France	0.0126	0.0142	0.0695
Hong Kong	0.0284	0.0154	0.0817
Japan	0.0001	0.0126	0.0973
Netherland	0.0149	0.0148	0.3120
New Zealand	0.0139	0.0031	0.0758
Singapore	0.0211	0.0106	0.0497
Switzerland	0.0198	0.0087	0.0681
UK	0.0263	0.0166	0.1517
US	0.0308	0.0086	0.3270
Mean, high-income	0.0192	0.0113	0.1281
Panel B: Developing countries			
Brazil	0.0836	0.0241	0.0243
China	0.0880	0.0200	0.5081
India	0.0108	0.0209	0.1626
Indonesia	0.0098	0.0121	0.0477
South Korea	0.0715	0.0220	0.3317
Malaysia	0.0404	0.0226	0.0523
Mexico	0.0860	0.0104	0.0497
Vietnam	0.0381	0.0344	0.1846

Table 1

Continued

	Abs(Return)	Volatility	Turnover
Country	μ(%)	μ (%)	μ(%)
Mean, developing countries	0.0535	0.0208	0.1701
Mean, all	0.0330	0.0151	0.1450

Table 2 Summary Statistics (Monthly Data)

For each country, I report the mean (μ) for monthly absolute returns, volatility, and turnover. Units are percent per month. Panel A summarizes results for high-income markets, whereas panel B summarizes results for developing countries.

	Abs(Return)	Volatility	Turnover
Country	μ(%)	(%)	μ(%)
Panel A: High-income country			
Australia	3.0947	1.3273	2.6158
Belgium	2.7141	2.4543	2.7998
Canada	2.4541	1.8647	3.9567
France	1.8769	3.4242	2.0001
Hong Kong	3.9969	3.2417	2.2192
Japan	0.0156	3.0471	3.2224
Netherland	2.0479	3.2575	8.4322
New Zealand	1.9471	1.0123	2.2786
Singapore	3.0042	2.1119	1.3454
Switzerland	2.9913	2.0004	2.0897
UK	4.2214	3.5267	5.3374
US	4.5796	1.5217	9.8762
Mean, high-income	2.7453	2.3992	3.8478
Panel B: Developing countries			
Brazil	7.4312	4.2376	0.8886

Table 2

Continued

	Abs(Return)	Volatility	Turnover
Country	μ(%)	(%)	μ(%)
China	7.3467	4.0089	9.9915
India	1.5346	3.7865	5.3487
Indonesia	0.8976	2.1768	1.4235
South Korea	6.4319	4.6795	9.9809
Malaysia	5.3221	5.9801	1.5646
Mexico	8.4562	1.8709	1.3428
Vietnam	4.5853	5.7864	5.4386
Mean, developing countries	5.2507	4.0656	4.5284
Mean, all	3.7475	3.0659	4.1201

examined in Panel B, turnover also varies across markets. China and South Korea have highest turnover, over 0.3 per cent per day, whereas turnover in Brazil, Indonesia, Malaysia, and Mexico is below 0.1 per cent per day. The average volatility of developing markets is 0.0208% per day, higher than that of high-income countries (0.0113%) per day. The average absolute return of developing countries is 0.0535% per day, higher than that of high-income countries (0.0192%) per day.

To compare the volume-variability relation across countries over time, I also present the summary statistics in Table 2 for monthly variability, turnover, and volatility for 20 countries, including both developing countries and high-income countries. Similar patterns in absolute returns, volatility and turnover are found in Table 2. The average absolute return of developing countries is 5.2507% per month, higher than that of high-income countries (2.7453%) per month. In high-income countries, Netherland and the US have the highest turnover, over 8% per month, which is followed by UK (5.3374%) per month. Singapore, France, and Switzerland rank the bottom three in turnover, less than 2.1% per month. In developing countries, turnover in China and South Korea is about 10% per month, while Brazil has the smallest turnover (0.8886%) per month.

5.2 Estimating the Absolute Return-Volume Relation

5.2.1 Short-Term relation

My main tool for estimating absolute the return-volume relation is VAR model on a country-by-country basis. Because individual VAR coefficient estimates do not capture the full impact of an exogenous observation, I use associated impulse response function to trace the full impact of a shock until the relation reaches equilibrium. The responses are expressed in standard deviation units. The Augmented Dickey-Fuller test rejects the null hypothesis of a unit root for each country series. In addition, by using AIC, BIC, and LR test, the appropriate lag length is chosen for the VARs estimation for each country.

Figure 1 presents the bivariate cumulative impulse response functions measuring the effect of a one standard deviation shock to daily absolute returns on volume. The summary statistics of Figure 1 are found in Table 3.

Figure 1 suggests that turnover is related to absolute returns in all countries. In Table 3, the cumulative impulse response of turnover to absolute returns generally shows an increasing trend over time. After ten days, an absolute return shock is accompanied by an increase in turnover in 20 countries. On average, a 0.0097 standard deviation increase in turnover follows one standard deviation shock of absolute return after one day, while 0.0121 standard deviation increase in turnover after five days, and 0.0154 standard deviation increase in turnover after ten days. However, there are large differences in the relation of absolute return and volume between high-income countries and developing markets. After one day, a one standard deviation to absolute returns is followed by 0.0067 standard deviation increase in turnover in high-income countries, while at the same frequency in developing countries, a one standard deviation in absolute return is followed by 0.0143 standard deviation increase in turnover. After five days, a one standard deviation shock to absolute returns is followed by 0.0081 standard

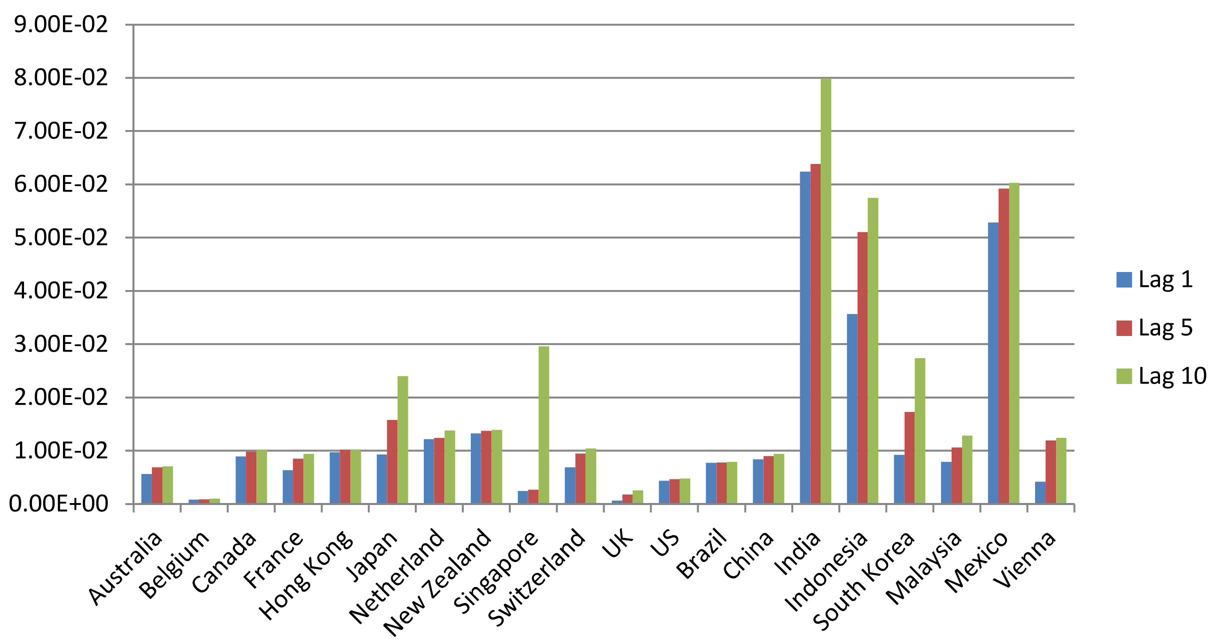

Figure 1

Cumulative Impulse Response Functions From Bivariate Vector Autoregressions

Daily returns and turnover are used to estimate country-by-country bivariate VARs. The figure reports the generalized impulse response function of turnover to a one standard deviation shock in absolute return at lags one, five, and ten days in each country. All responses are standardized by the standard error. Turnover is scaled by market capitalization. High-income countries are in alphabetical order on the left side of the graph and developing countries are on the right.

Table 3

Summary Statistics of Impulse Response Functions—Daily Data

	High Income					Developing Countries					All Countries				
IRF	μ	Med	σ	-	+	μ	Med	σ	-	+	μ	Med	σ	-	+
Lag 1	0.0067	0.0066	0.0017	0	20	0.0143	0.0034	0.0051	0	20	0.0097	0.0021	0.0187	0	20
Lag 5	0.0081	0.0090	0.0023	0	20	0.0181	0.0063	0.0061	0	20	0.0121	0.0027	0.0063	0	20
Lag 10	0.0114	0.0102	0.0069	0	20	0.0215	0.0082	0.0090	0	20	0.0154	0.0040	0.0109	0	20

For each country-level VAR, I compute the generalized impulse response function of turnover to a one standard deviation shock to absolute return at various lags. The table reports the mean (μ), median (Med), and standard deviation (σ) of the responses for high-income, developing, and all countries. I also report the number of positive (+), and negative (-) responses.

deviation increase in turnover in high-income countries, while in developing countries, the response is 0.0181 standard deviation. After ten days, a one standard deviation shock to absolute returns is followed by 0.0114 standard deviation increase in turnover in high-income countries, while in developing countries, a one standard deviation in absolute return is followed by 0.0215 standard deviation increase in turnover.

The magnitude of absolute return-volume relation varies across countries within high-income country and developing country. In Canada, Hong Kong, Japan, Netherland, and New Zealand, a one standard deviation shock to absolute return is followed by a larger increase in turnover (more than 1% standard deviation) after five days, while for Belgium, a one standard deviation shock to absolute return is followed by a smallest increase in turnover(0.08% standard deviation). In developing markets, India, Indonesia, South Korea, Malaysia, Mexico, and Vienna show a greater response in turnover to one standard deviation shock to absolute returns (larger than 1% standard deviation), while in Brazil and China, a one standard deviation shock in absolute return is followed by around 0.8% (smaller than 1%) standard deviation increase in turnover after five days.

5.2.2 Long-Term Relation

To examine the volume-variability relation over longer periods, I also investigate the bivariate model on a monthly basis across countries. Figure 2 presents the bivariate cumulative impulse response functions measuring the effect of a one standard deviation shock to monthly variability on volume. The summary statistics of Figure 2 are found in Table 4.

Table 4 indicates similar short-term trends as those in Table 3, but there are some reversals of volume-variability relation in 5-6 countries after five and ten months. More specifically, after ten months, an absolute return shock is accompanied by an increase in turnover in 14 countries, but accompanied by a decrease in 6 countries. An average 1.8053 standard deviation increase in turnover follows one standard deviation shock of absolute return after one month, while 1.5728 standard deviation increase in turnover after five months, and 1.7495 standard deviation increase in turnover after ten months.

However, there are large differences in the relation of absolute return and volume between high-income countries and developing markets. After one month, a one standard deviation to absolute returns is followed by 0.6868 standard deviation increase in turnover in high-income countries, while at the same frequency in developing countries, a one standard deviation in absolute return is followed by 3.4829 standard deviation increase in turnover. Similar patterns can be found for after five months (0.7881 standard deviation increase in turnover in high-income countries, while 2.3490 standard deviation increase in developing countries) and after ten months (0.8937 standard deviation increase in turnover in high-income countries, while 2.6242 standard deviation increase in developing countries). Comparing the reversal of the volume-variability relation between high-income countries and developing countries, in general reversal is more likely in developing countries.

The magnitude of absolute return-volume relation varies across countries within high-income country and developing country. After five months, in high-income countries, only Singapore shows a reversal of volume-variability relation, while in developing countries, Brazil, Malaysia, Mexico, and Vienna present a picture of reversal of volume-variability relation. After ten months, only Singapore shows a reversal of volume-variability relation, while in developing countries, five countries including Brazil, China, Malaysia, Mexico, and Vienna show a reversal of their volume-variability relation.

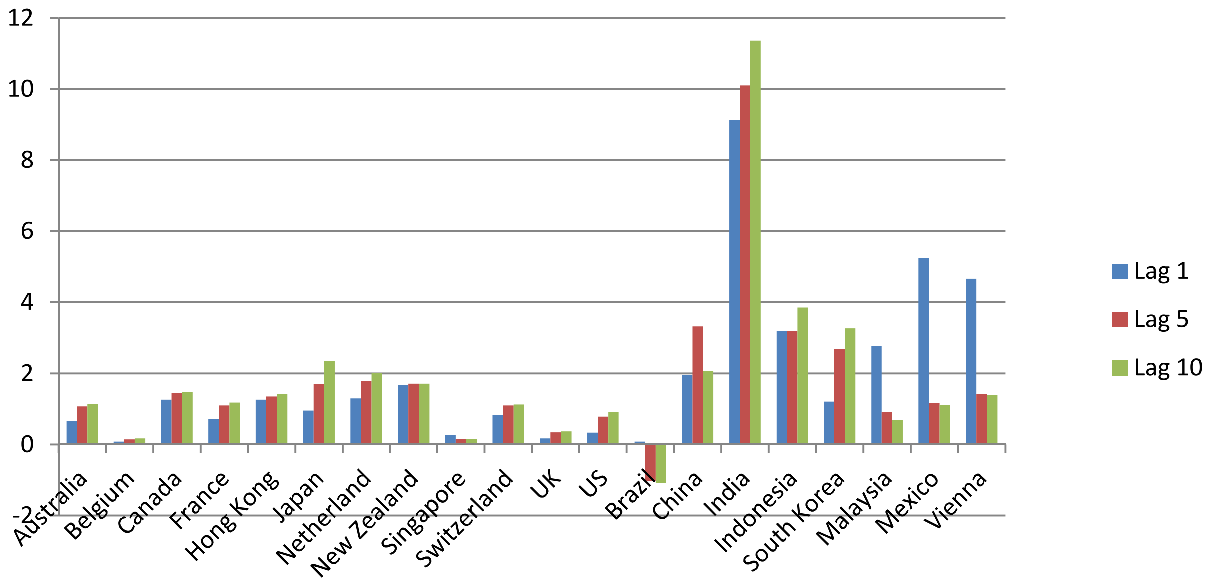

Figure 2

Cumulative Impulse Response Functions From Bivariate Vector Autoregressions

Monthly returns and turnover are used to estimate country-by-country bivariate VARs. The figure reports the generalized impulse response function of turnover to a one standard deviation shock in absolute return at lags one, five, and ten months in each country. All responses are standardized by the standard error. Turnover is scaled by market capitalization. High-income countries are in alphabetical order on the left side of the graph and developing countries are on the right.

Therefore, comparing the short-term and long-term volume-variability relation, there is no reversal of volume-variability relation after five or ten days in all countries, when focusing on monthly data; both high-income countries and developing countries show a reversal of volume-variability relation after five or ten months.

Table 4

Summary Statistics of Impulse Response Functions—Monthly Data

	High Income					Developing Countries					All Countries				
IRF	µ	Med	σ	-	+	µ	Med	σ	-	+	µ	Med	σ	-	+
Lag 1	0.6868	0.6632	0.1776	0	12	3.4829	3.1220	0.8524	0	8	1.8053	1.0186	1.3501	0	20
Lag 5	0.7881	0.8992	0.2171	1	11	2.3490	1.2947	1.1826	4	4	1.5728	0.9986	2.6615	5	15
Lag 10	0.8937	0.8217	0.3946	1	11	2.6242	1.3547	1.1907	5	3	1.7495	1.0157	2.4021	6	14

For each country-level VAR, I compute the generalized impulse response function of turnover to a one standard deviation shock to absolute return at various lags. The table reports the mean (µ), median (Med), and standard deviation (σ) of the responses for high-income, developing, and all countries. I also report the number of positive (+), and negative (-) responses.

5.3Estimating Cultural factors and Other Cross-Country Variations

Table 5 reports the regression results, where the dependent variable is the five-day response of turnover to absolute return for each country in each year (total number of observations = 20 countries*number of years, which varies across countries). A country random effect is incorporated in the regression analysis, since there might be other country factors not captured by our model. In regression (1), the independent variables include short sale dummy variable, financial development, information asymmetry, Hofstede's cultural factors, and age distribution. The absolute return-volume relation is much stronger in countries with short-sale restrictions, meaning that volume-price variability relation tend to be stronger when short sale is costly and such relation increases with the information asymmetry. Financial development is proxied by market capitalization to GDP and GDP per capita, which are significantly negatively related to the volume-variability relation. This result suggests that in less financially-developed countries, the volume-variability relation tends to be stronger. A potential explanation is that trading noise might be more in less developed countries and some studies suggest trading noise is a cause of volatility. In this study, the number of analysts, forecast error, and disclosure represent proxies for information environment. As I argue earlier, in more opaque countries, the volume-variability relation tends to be stronger. The coefficient of number of analyst is negative and significant, while the coefficient of forecast error is positive and significant. Disclosure has an insignificant but negative effect on the volume-variability relation. Therefore, the results again suggest that the relation between absolute value of return and volume increases with information asymmetry. Regarding cultural factors, IDV and MSI are positively related to the volume-variability relation, whereas PDI and UAI are significantly negative related to the volume-variability relation. Therefore, the results indicate that for countries with high level of individualism and are more masculine, individuals are more likely to trade following large shocks. It supports the hypothesis that people in individualistic culture are overoptimistic about their abilities, and they tend to overestimate the precision of their prediction. Hence, individualism tends to be positively related to the relationship between absolute value of returns and volume. Similarly, the results are supportive of the expectation that people in more masculine countries are more assertive and competitive, and are more likely to take risk. Hence, masculine index tends to be positively related to the volume-variability relation. The signs of the other two cultural dimensions, PDI and UAI, are also consistent with expectations. As predicted, age distribution, a measure of the weighted average age of each country, is negatively related to volume-variability relation. As people get older, they are more risk averse and less actively participating in trading activity, therefore, the volume-variability relation is weaker as the average age of population increases. As additional robust checks, I estimate two additional regression models as described below. Regression (2) of Table 5 excludes IDV; the results are consistent with those of the full model except that PDI is no longer significant. Regression (3) of Table 5 excludes PDI, and the results indicate that all variables are significant. Therefore, the results regarding PDI are not robust.

To verify the robustness of my findings regarding cultural factors (Hofstede (1997)), I also use GLOBE's (Global Leadership and Organizational Behavior Effectiveness) cultural dimensions (House, Hanges, Javidan, Dorfman and Gupta (2004)) to further study on the volume-variability relation. The GLOBE's cultural factors are classified into nine dimensions: Uncertainty Avoidance (UA), Institution Collectivism (IC), Power Distance (PD), and Assertiveness, Performance Orientation, Future Orientation, In-Group Collectivism, and Gender Egalitarianism. Among these dimensions, the institutional collectivism is intended to reflect the opposite of Hofstede's individualism (House, Robert, Javidan, Hanges, and Dormfman, 2002). That is, GLOBE's institutional collectivism reflects the degree of collectivism in each country, and the higher the score in this index, the lower degree of individualism is implied. Consistent with expectation from Hofstede's four cultural factors on volume-variability relation, I hypothesize that for countries that are more rule-oriented, more cohesive, and more acceptable authority, there is a weaker volume-variability relation; that is, the volume-variability relation should decrease with IC, PD, and UA. To be more specific, a negative effect of PD and UA on the volume-variability relation is expected. If traders are more assertive, and more likely to take risk, the return-variability relation should be stronger, suggesting that a high level of assertiveness induce a strong return-variability relation. Regression (1) of Table 6 presents the results using GLOBE's cultural factors, as well as short sales dummy, information asymmetry, financial development and age distribution on return-variability relation. The results are generally similar to those reported in regression (1) of Table (5). The results show that IC has a significant negative effect on return-variability relation, meaning that in a country where individuals are more likely to express pride, loyalty, and cohesiveness, there is a weaker return-variability relation. Besides that, Assertiveness has a positive but insignificant effect on return-variability relation. Power distance and uncertainty avoidance are significantly negatively related to the volume-variability relation. As additional checks, in regressions (2), I exclude IC, and in regression (3), I exclude PD and UA. The results show that IC is still significant, but PD and UA are no longer significant.

In general, my results provide evidence that in countries with high level of individualism and masculinity, people tend to be more overoptimistic, thereby inducing a stronger return-variability relation. In addition, I find that return-variability relation is stronger in less financially-developed countries with short-sale constraints and high information asymmetry.

6. Conclusion

This study examines the relation between volume and price variability in 20 countries for sample period of January 2, 1993 through September 1, 2011. Turnover is strongly and

Table 5

Cross-Sectional Regression Analysis - based on Hofstede's Cultural Factors

The dependent variable is the five-day response of turnover to absolute return shock in each country each year obtained from a generalized impulse response function in a vector autoregression with absolute return, and turnover. Log (GDP) per capita is the natural logarithm of per capita gross domestic product. Market cap/GDP is the ratio of stock market capitalization to gross domestic product. The number of analysts and the precision of analyst forecast are from Chang, Khanna, and Palepu (2000). Disclosure is a measure of transparency, which is from La Porta, Lopez-de-Silanes, and Shleifer (2006). Short sales dummy variable that equals 1 if short sale are allowed, which is from Bris, Goetzmann, and Zhu (2006). IDV, MAS PDI, and UAI are four culture factors developed by Hofstede (1997). Age is measured as weighted average age of population of persons 20 and older of each country, which is obtained from U.S. Census Bureau. This table reports the random-effect estimates as well as the adjusted heteroskedasticity (White) p value. The asterisk *, **, and *** indicate 1%, 5%, and 10% significance levels.

Variables	(1)	(2)	(3)
Short Sale	-0.0061***	-0.0041**	-0.0023***
	(0.0012)	(0.0289)	(0.0034)
Market cap/GDP	-0.0002*	-0.0003*	-0.0003*
	(0.0879)	(0.0854)	(0.0912)
Log GDP per capita	-0.0034*	-0.0019*	-0.0020*
	(0.0913)	(0.0967)	(0.0932)
Forecast Error	0.0260***	0.0125***	0.0134***
	(0.0004)	(0.0059)	(0.0056)
Number of Analysts	-0.0011***	-0.0009***	-0.0005***
	(0.0001)	(0.0003)	(0.0001)
Disclosure	-0.0012	-0.0004	-0.0009
	(0.2893)	(0.3334)	(0.2989)
IDV	0.0040***		0.0041***
	(0.0016)		(0.0015)
MAS	0.0012***	0.0010***	0.0011***
	(0.0014)	(0.0098)	(0.0034)
PDI	-0.0001*	-0.0003	
	(0.0658)	(0.1232)	
UAI	-0.0019**	-0.0018**	-0.0020**
	(0.0356)	(0.0435)	(0.0324)
Age	-0.0039**	-0.0041**	-0.0030**
	(0.0111)	(0.0312)	(0.0302)
Adjusted R^2	0.45	0.32	0.41
Number of observations	345	345	345

Table6

Cross-Sectional Regression Analysis -Based on CLOBE's Cultural Factors

The dependent variable is the five-day response of turnover to absolute return shock in each country each year obtained from a generalized impulse response function in a vector autoregression with absolute return, and turnover. Log (GDP) per capita is the natural logarithm of per capita gross domestic product. Market cap/GDP is the ratio of stock market capitalization to gross domestic product. The number of analysts and the precision of analyst forecast are from Chang, Khanna, and Palepu (2000). Disclosure is a measure of transparency, which is from La Porta, Lopez-de-Silanes, and Shleifer (2006). Short sales dummy variable that equals 1 if short sale are allowed, which is from Bris, Goetzmann, and Zhu (2006). Assertiveness, IC, PD and UA are four culture factors developed by House, Hanges, Javidan, Dorfman and Gupta (2004). IC is intended to reflect Hofstede's individualism index. PD is the extent to which a community accepts and endorses authority, power differences and status privileges. UA is the extent to which a society, organization, or group relies on social norms, rules, and procedures to alleviate the unpredictability of future events. Age is measured as weighted average age of population of persons 20 and older of each country, which is obtained from U.S. Census Bureau. This table reports the random-effect estimates as well as the adjusted heteroskedasticity (White) p value. The asterisk *, **, and *** indicate 1%, 5%, and 10% significance levels.

Variables	(1)	(2)	(3)
Short Sale	-0.0074***	-0.0019**	-0.0020**
	(0.0012)	(0.0322)	(0.0213)
Market cap/GDP	-0.0013*	-0.0009*	-0.0011*
	(0.0978)	(0.0923)	(0.0897)
Log GDP per capita	-0.0021*	-0.0019*	-0.0023*
	(0.0923)	(0.0832)	(0.0989)
Forecast Error	0.0275***	0.0098***	0.0103***
	(0.0004)	(0.0012)	(0.0010)
Number of Analysts	-0.0005***	-0.0002***	-0.0003***
	(0.0001)	(0.0011)	(0.0009)
Disclosure	-0.0009	-0.0006	-0.0008
	(0.3344)	(0.4362)	(0.3254)
IC	-0.0126***		-0.0082**
	(0.0075)		(0.0287)
PD	-0.0105*	-0.0212	
	(0.0946)	(0.2019)	
UA	-0.0023*	-0.0012	
	(0.0813)	(0.1923)	
Assertiveness	0.0027	0.0021	0.0022
	(0.9616)	(0.9489)	(0.9879)
Age	-0.0004***	-0.0002**	-0.0003***
	(0.0097)	(0.0102)	(0.0092)
Adjusted R^2	0.40	0.24	0.37
Number of observations	345	345	345

positively related to absolute returns in the majority of countries here. However, such relation is much stronger in developing countries than that in high-income countries. On average, a one standard deviation shock to absolute returns in developing countries is followed by 0.0143 standard deviation increase in turnover after one day, and 0.0181 standard deviation increase in turnover after five days, and 0.0215 standard deviation increase in turnover after ten days. The response in high-income countries is 0.0067 standard deviation in turnover after one day, and 0.0081 standard deviation after five days, and 0.0114 standard deviation after ten days. Although the results show a consistent pattern that turnover follows absolute return in many markets, the relation diminishes over time in both high-income countries and developing countries. Using monthly data, five countries show reversal of volume-variability relation after five months, while six countries show reversal of the volume-variability relation after ten months.

With regard to the factors that affect the volume-variability relation, my findings support the hypothesis that for less financially-developed countries with high degree of information asymmetry, and short sale restriction, there is a stronger volume-variability relation. There is also evident that cultural factors indeed have effect on the volume-variability relation. For countries with higher value of individualism and masculine, there is a stronger volume-variability relation. With regard to cultural dimensions of power distance and uncertainty avoidance, the results are also consistent with my expectations though not quite robust. To verify the robustness of effect of cultural factors on the volume-variability relation, I also use GLOBE's cultural factors to measure the effect. In particular, in GLOBE, institutional collectivism reflects Hofstede's individualism index. Similarly results are obtained that there is a weaker volume-variability relation for countries with high level of institutional collectivism. The evidence is inconclusive regarding other GLOBE factors, including power distance, and uncertainty avoidance.

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Appendix A

GLOBE is an acronym for "Global Leadership and Organization Behavior Effectiveness," a 62 nation, 11-year study involving 170 researchers worldwide. It compares countries on nine critical cultural dimensions (see below) and discusses the implications of the cultural similarities and differences for global managers.

Cultural Dimensions	Definitions
Performance Orientation	The extent to which a community encourages innovation, high standards, excellence, and performance improvement
Uncertainty Avoidance	The extent to which a society, organization, or group relies on social norms, rules, and procedures to alleviate the unpredictability of future events
In-Group Collectivism	The degree to which individuals express pride, loyalty, and cohesiveness in their organizations or families
Power Distance	The extent to which a community accepts and endorses authority, power differences and status privileges
Gender Egalitarianism	The degree to which a collective minimized gender inequality
Humane Orientation	The degree to which organization or society encourages and rewards individuals for being fair, altruistic, friendly, generous, caring and kind to others
Institutional Collectivism	The degree to which organizational and societal institutional practices encourage and reward collective distribution of resources and collective action
Future Orientation	The degree to which a collective encourages and rewards future-oriented behaviors such as planning and delaying gratification
Assertiveness	The degree to which individuals are assertive, confrontational, and aggressive in their relationship with others

Source: Regional definition from http://www.fuquaccl.wordpress.com/tag/institutional-collectivism

Chapter 2

Causes and Effects of Large One-Day Price Changes: The Case of Commodity Futures

1.Introduction

Blume, Easley and O'Hara (1994) find that a large price change is a good proxy for information signal. Motivated by this finding and the overreaction hypothesis (De Bondt and Thaler, 1985) that suggests extreme movements in price changes will be followed by subsequent price movements in the opposite direction, in this paper, I investigate causes and effects of large one-day price changes in commodity futures in the U.S. market. More specifically, the first part of study attempts to infer the causes of large price changes by identifying the patterns of occurrence (opening or closing, near maturity or distant maturity contracts, and seasonal effects). These patterns might offer clues to the potential causes. The second part of the study analyzes the effects of these large price changes and analyzes whether the effects vary with systematic risks.

Previous studies on price behavior following large price changes (e.g., Atkins and Dyl, 1990; Bremer and Sweeney, 1991; Grant, Wolf and Yu, 2005) focus on either the stock markets or stock index futures markets. In this paper, I examine the price behavior following large one-day price changes in 26 U.S. commodity futures markets. The study represents the first attempt to examine price patterns following large price changes in the commodity markets. There are several reasons to study large price changes in commodity futures. First, large changes in commodity prices are more likely caused by macroeconomic news and not by firm-specific news. Moreover, news tend to be announced near market opening, and therefore I expect more large price changes to occur in the opening. Opposite results would suggest that noise trading is also an important driver of large price changes. Moreover, Sameulson (1965) proposes a "maturity effect" that large price changes tend to occur near maturity of futures; if so, large price changes are not entirely driven by information.[9] By examining futures contracts of various maturities, I can assess the likelihood of these large changes caused by information. Second, players in the futures market might be on average better trained and better informed than stock market players as they are more likely to be professional and institutional investors. Thus, it would be interesting if overreaction or underreaction, even if only temporary, can be found among this group. On the other hand, commodity futures are harder to arbitrage and are more affected by seasonality, which implies that mispricing, if any, might be more persistent than financial futures. Therefore, whether commodity futures are characterized by a higher or lower degree of overreaction than index futures is an issue worth investigating. Third, I also employ a model that incorporates the effects of business cycle.

The remaining sections of this paper are organized as follows: Section 2 comprises a literature review on both causes and effects of large price changes. Section 3 describes the data. Section 4 discusses the methodology. Section 5 presents empirical evidence. Section 6 concludes.

[9] It is worth noting that clustering of information flows near delivery dates is not a necessary condition for the success of the Samuelson's hypothesis; see Bessembinder, Coughenour, Seguin and Smeller(1996).

2.Literature Review

2.1Causes of Large Price Changes

2.1.1 Information and Noise

Macroeconomic issues tend to be announced near the market opening; thus, big changes in opening price can be explained by announcements of macroeconomic news. Examples of these announcements include economic growth, inflation, changes in employment and unemployment, trade performance with other countries, and government economic policies and decisions. Schwert (1981), Pearce and Roley (1985), and Hardouvelis (1987) find monetary policy surprises (inflation, money supply and interest rate) have a strong effect on stock prices. Using the hourly data around the announcement time, Jain (1988) shows both monetary and inflation surprises significantly affect stock price. McQueen and Roley (1993) find news are responsible for stock prices changes on a daily-basis. Ederington and Lee (1993) examine the impact of macroeconomic news on interest rate and foreign futures markets and find a strong relationship between announcement and most of the observed time-of-day and day-of-the-week volatility patterns. For the bond market, the empirical evidence is generally strong. Grossman (1981), Urich and Wachtel (1981), Cornell (1982, 1983), Roley (1983) and Hardouvelis (1988) find significant impacts of money supply announcements during the 1970s and early 1980s period. Further, Fleming and Remolona (1997) show that, for the five-year Treasury note, prices change the sharpest from 8/23/1993 through 8/19/1994 in response to announcement, and most changes are within 15 minutes of announcement release. Balduzzi, Elton and Green (2001) suggest that public news are responsible for a substantial fraction of price volatility after the announcement, and the adjustment to news generally happens within one minute in the aftermath of announcement.

French and Roll (1986, p.5) suggest that noise trading is also important; they state that, "asset prices are much more volatile during exchange trading hours than during non-trading hours." They provide two explanations for this phenomenon: (1) information arrives more frequently during the business day; (2) the process of trading itself introduces noise into price. Therefore, large price changes at the market closing might be mostly due to trading noise. Black (1986) states that people who trade on noise think noise is information and are willing to trade on noise even though they would be better off not trading. DeLong, Shleifer, Summers and Waldmann (1990) state that the presence of noise traders in financial markets can cause prices and risk levels to diverge from expected levels even if all other traders are rational. That is, from the theoretical point of view, trading by not fully rational noise traders can drive prices away from fundamental values.

2.1.2 Maturity Effect

Samuelson (1965) was the first to suggest the maturity effect, stating that futures price volatility increases as the futures contract approaches the maturity. The intuition under this hypothesis is that as futures contract approaches maturity, its price must converge to the spot price; thus, it tends to fluctuate more significantly. Therefore, the price volatility should increase as the time to maturity shortens.[10]

Earlier studies focus on the rate of information flow to explain the maturity effect (e.g., Anderson and Danthine, 1983; Kolb, 1991). A recent extension of Samueslon's hypothesis is found in Bessembinder, Coughenour, Seguin and Smeller (1996). They argue that neither the clustering of information flows near delivery dates nor the assumption that each futures price is an unbiased forecast of the delivery date spot price are necessary conditions for the success of this hypothesis.[11] However, by employing no-arbitrage "cost-of-carry" model, they argue that the Samuelson hypothesis will be supported in those markets that exhibit negative correlation between spot price changes and changes in the slope of futures term structure. They find strong empirical evidence for the maturity effect in agricultural and oil markets, but weaker evidence in the metal market and no evidence in financial futures.

Previous empirical studies find some support for Samuelson's hypothesis in commodity markets. Rutledge (1976) finds support in both silver and cocoa contracts. Milonas (1986) finds evidence for Samuelson's hypothesis in 10 of 11 agricultural and metal futures. Galloway and Kolb (1996) also support the hypothesis by studying agricultural futures. In international markets, Allen and Cruickshank (2000) find strong support for the maturity effect in commodity

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[10] Samuelson's hypothesis is based on two assumptions that (1) each futures price equals the trading date expectation of the delivery date spot price, and (2) that the spot price itself follows a first order autoregressive process, with an AR(1) coefficient equal to 0.5.

[11] Bessembinder, Coughenour, Seguin and Smeller (1996, p. 3), writes, "In the case of agricultural futures in particular, contracts mature not only near harvest dates, but throughout the year. …… Therefore, explanations that invoke systematic variation in rates of information flow are unlikely to provide accurate cross-sectional predictions regarding the validity of the Samuelson hypothesis."

futures in the Sydney Futures Exchange, London International Financial Futures Exchange (LIFFE), and Singapore Derivatives Exchange.

2.1.3 Seasonal Effects

Most commodities are subject to the laws of demand and supply, but demand/supply imbalance might be more severe in certain times. For example, in agricultural markets (e.g., soybean, wheat, coffee, cocoa), prices are driven by seasonal supply (e.g., harvest, planting, weather conditions and transportation systems). In energy markets (e.g., heating oil, gasoline), prices are driven by seasonal demand (e.g., cold weather). Livestock (e.g., hog and cattle) also tend to be affected by seasonal effect (e.g., production and marketing). Milonas (1991) finds that seasonality effect is a major factor in commodity pricing process. He argues that for agricultural commodities, information about the factors (e.g., humidity and temperature) that affect the crop quality is continuously disseminated in the markets. Consequently, the volatilities tend to be greatest in months where the changing weather conditions lead to significant price adjustments. There is no reason to restrict seasonal effects to certain months. Similar month effects in agricultural commodities are documented by Roll (1984), Anderson (1985), and Fama and French (1987).

2.2 Effects of Large Price Change

According to Bremer, Hiraki and Sweeney (1997), research on overreaction is classified into three groups based on time horizons. The first group covers research on overreaction in the longer term, as long as 3-5 years. Examples include De Bondt and Thaler (1985), Chan

(1988), Ball and Kothari (1989), and Chan and Chen (1991). They generally find a tendency for price reversal. The second group includes studies on reversals in weeks or months. Jegadeesh (1990) and Lo and MacKinlay (1990) find reversals in intermediate return data. The third group includes short-term price rebounds, which occurs in a few days after price shocks. For example, Atkins and Dyl (1990) find evidence of strong price reversals on common stocks after a large price change without considering transaction costs. Bremer and Sweeney (1991) report that stock prices reverse significantly following one-day price decline of 10% or more for Fortune 500 stocks and price reversal is not related to the calendar effects. Park (1995) finds that price reversals persist for short-run period except on day+1 by using the average of the bid and ask prices. Further, transaction costs cannot explain the abnormal returns. Bremer, Hiraki and Sweeney (1997) report significant positive returns of firms in the Nikkei 300 following large price decreases, but little evidence of significant patterns following large price increases.

Fung, Mok, and Lam (2000) add another study on overreaction that occurs on the same day as that a big price change occurs. They find large intraday price reversals after price changes in the S&P 500 Futures market and the Hang Seng Index Futures market. Similarly, Grant, Wolf and Yu (2005) find significant intraday price reversals in the US stock index futures market after large price changes at the market opening. Further, the strength of the intraday overreaction seems more pronounced following large positive price changes than negative price shocks at the market opening.

Although an extensive literature supports reversals following large price changes, there are some exceptions. Using daily market indexes from 39 stock exchanges over the period 1989 to 1998, Lasfer, Melnik and Thomas (2003) find positive (negative) abnormal price returns in the short-term window (up to 10 days) following positive (negative) price shocks, which is not consistent with the overreaction hypothesis, but supports the momentum theory in stock indexes. Similar results are documented in Mazouz, Alrabadi and Yin (2011), who analyzes a yearly updated constituents list of Financial Times and the London Stock Exchange (FTSE) all share indexes and find that positive (negative) shocks tend to be followed by positive (negative) abnormal returns.

In brief, studies of price behavior following large price changes tend to support two contrasting hypotheses of overreaction and underreaction. Although there seems to be no consensus in the literature on which one prevails, overall there seems to be more support for overreaction.

3.Data

I use a wide range of commodity futures, including energy, food (non-grains), grains, metals/fiber, and livestock. To be more specific, 26 commodity futures are included, namely, Crude Oil, Heating Oil, Natural Gasoline, Cocoa, Orange Juice Frozen, Coffee, Sugar, Soybean Oil, Corn, Kansas City Wheat, Minnesota Wheat, Oats, Soybeans, Soybean Meal, Wheat, Cotton, Gold, Copper, Lumber, Palladium, Platinum, Silver, Feeder Cattle, Live Cattle, Live Hogs, and Pork Bellies. Except for Crude Oil, Heating Oil, Minnesota Wheat, and Natural Gas, other commodity futures span over 30-year period from 01/03/1978 to 06/02/2008. Crude oil spans from 03/30/1983 to 06/02/2008, Heating Oil covers a period from 03/06/1979 through 06/02/2008, and Minnesota Wheat spans from 11/18/1980 to 06/02/2008, while Natural Gas

Table 1 Data Summary

Futures price series	Start date	Close date	Contract Months	Futures Exchange
Crude Oil	03/30/1983	06/02/2008	Every Month	NYMEX①
Heating Oil	03/06/1979	06/02/2008	Every Month	NYMEX
Natural Gasoline	04/03/1990	06/02/2008	Every Month	NYMEX
Gold	01/03/1978	06/02/2008	Every Month	CME②
Copper	01/03/1978	06/02/2008	Every Month	CME
Silver	01/03/1978	06/02/2008	Every Month	CME
Cocoa	01/03/1978	06/02/2008	3,5,7,9,12	CSCE③
Corn	01/03/1978	06/02/2008	3,5,7,9,12	CBOT④
Coffee	01/03/1978	06/02/2008	3,5,7,9,12	CSCE
Kansas City Wheat	01/03/1978	06/02/2008	3,5,7,9,12	KCBT⑤
Minnesota Wheat	11/18/1980	06/02/2008	3,5,7,9,12	MGEX⑥
Oats	01/03/1978	06/02/2008	3,5,7,9,12	CBOT
Wheat	01/03/1978	06/02/2008	3,5,7,9,12	CBOT
Soybean Oil	01/03/1978	06/02/2008	1,3,5,7,8,9,10,12	CBOT
Soybean Meal	01/03/1978	06/02/2008	1,3,5,7,8,9,10,12	CBOT
Soybeans	01/03/1978	06/02/2008	1,3,5,7,8,9,11	CBOT
Orange Juice Frozen	01/03/1978	06/02/2008	1,3,5,7,9,11	ICE⑦
Lumber	01/03/1978	06/02/2008	1,3,5,7,9,11	CME
Cotton	01/03/1978	06/02/2008	3,5,7,10,12	CSCE
Sugar	01/03/1978	06/02/2008	3,5,7,10	CSCE
Palladium	01/03/1978	06/02/2008	3,6,9,12	CME
Platinum	01/03/1978	06/02/2008	1,4,7,10	CME
Feeder Cattle	01/03/1978	06/02/2008	1,3,4,5,8,9,10,11	CME
Live Cattle	01/03/1978	06/02/2008	2,4,6,8,10,12	CME
Live Hogs	01/03/1978	06/02/2008	2,4,6,7,8,10,12	CME
Pork Bellies	01/03/1978	06/02/2008	2,3,5,7,8	CME

①NYMEX-- New York Mercantile Exchange

②CME-- Chicago Mercantile Exchange

③CSCE-- Coffee, Sugar and Cocoa Exchange

④CBOT-- Chicago Board of Trade

⑤KCBT-- Kansas City Board of Trade

⑥MGEX— Minneapolis Grain Exchange

⑦ICE—Intercontinental Exchange

spans from 04/03/1990 to 06/02/2008. Table 1 provides the summary of sample data. I collect opening price, and closing price of these commodity futures from Commodity System Inc. Other data, such as government bond index, S&P composite index, and Goldman Sachs Commodities Index (GSCI) come from DataStream. I also collect default spread, and term structure of interest rates from Federal Reserve Bank of St. Louis website, as well as dividend yield from Shiller (2005).

4.Methodology

4.1 Identifying Large One-Day Price Changes

To infer whether announcements of macroeconomic news or noise trading is more likely to explain large price changes, I define the large price changes at the opening as the changes from previous day closing price to present day opening price, and the large price changes at the closing as the changes from present day opening price to closing price (intraday change). Because there is no clear consensus regarding what constitutes a "large" price change,[12] I initially define a positive (negative)shock as a daily returns of 5% or more (-5% or less). Then, I verify the robustness of my findings with different definitions: ±10%, ±15%, respectively. Further, based on Wong (1997) that utilizes dynamic trigger values based upon expected return and volatility, I define a positive (negative) price shock as one where the return on a particular day is above (below) two standard deviations the average market daily return computed over [-60 to -11] days relative to the day of the price shock. To avoid compounding effects, shocks that follow within 10 days of a given event day is excluded in the analysis.

[12]Shocks are defined in different ways in literature. Howe (1986) defined a shock as a weekly price change of 50 percent or more. Atkins and Dyl (1990) select stocks that exhibit the largest one-day price changes on 300 trading days. Bremer and Sweeney (1991), Cox and Peterson (1994) define a shock with a one-day price decline of 10 percent or more. Mazouz, Alrabadi and Yin (2009) investigate the price shocks in excess of 5, 10 and 20 percent.

4.2 Identifying Price Patterns

The essence of the test is to get a feel for potential drivers of large price changes. To determine whether information, maturity effect and seasonal effect are responsible for large price changes, a model is specified as follows:

$$
\begin{aligned}
Y_{it} &= \alpha_1 + \alpha_2 OPEN\_D_{it} + \alpha_3 JAN\_D_{it} + \alpha_4 FEB\_D_{it} + \alpha_5 MAR\_D_{it} + \alpha_6 APR\_D_{it} \\
&+ \alpha_7 MAY\_D_{it} + \alpha_8 JUN\_D_{it} + \alpha_9 JUL\_D_{it} + \alpha_{10} AUG\_D_{it} + \alpha_{11} SEP\_D_{it} + \alpha_{12} OCT\_D_{it} \\
&+ \alpha_{13} NOV\_D_{it} + \alpha_{14} \ln Mat_{it} + \varepsilon_{it}
\end{aligned}
\tag{1}
$$

where Y_{it} takes the value of 1 if a large price change occurs at day t for commodity futures i, 0 if no large price change occur at day t for commodity futures i, *OPEN_D* is a dummy variable that takes the value of 1 for price changes at the opening, 0 for price changes near the closing. I also include 11 dummy variables that proxy for seasonal effects, namely, *JAN_D, FEB_D, MAR_D, APR_D, MAY_D, JUN_D, JUL_D, AUG_D, SEP_D, OCT_D, and NOV_D. JAN_D* takes the value of 1 for price changes in January, 0 otherwise. The similar definition is applied to other 10 monthly dummy variables. December is the base month. The variable *Mat* is the number of days to maturity[13] .

The above regression will be performed for each commodity futures contract. If the parameter α_2 is positive and statistically significant, then large price changes are more likely to occur at the market opening, implying price changes are more likely caused by macroeconomic news; hence, less probability of reversal is expected. Large price changes near closing are more

[13] See work of Moosa and Bollen (2001) and Walls (1999).

likely caused by trading itself; thus, a larger probability of reversal might be expected, as DeLong, Shleifer, Summers and Waldmann (1990a) state that noise trader risk keeps arbitrageurs from driving prices to fundamental values. Significant parameters α_3 through α_{13} imply that seasonal effect can explain some large price changes. If the coefficient α_{14} is negative and significant, Samuelson's hypothesis holds, implying more occurrences of large price changes as the maturity is approached.

4.3 Examination of Effects of Large Price Changes

To examine whether greater probability of reversal (momentum) follows closing price changes than opening price changes, based on the study by Grant, Wolf, and Yu (2005), I first define cumulative returns of commodity futures, CAR_t, at day t after large price changes as:

$$CAR_t = \log P_t - \log P_0 \tag{2}$$

where P_t is the futures prices t days after the shock, and P_0 is the futures price at the day of shock.

In turn, the average cumulative returns t days after the shock are calculated as

$$ACAR_t = \frac{1}{N}\sum_{n=1}^{N} CAR_t \tag{3}$$

where N is the number of large price changes.

Moreover, a price reversal is said to exist if the sign of the average cumulative returns is different from the sign of the initial large price changes. Contrary to the definition of reversal, a price momentum is defined as the sign of the average cumulative returns is of the same sign of large price changes. In addition, a standard t-test is used to test whether $ACAR_t$ is significantly different from zero.

Then, to investigate the probability of reversal (momentum), I examine cumulative results from day 1 through day 10 following large price changes in both opening and closing.[14] The probability of reversal (momentum) of $ACAR_t$ is defined as the occurrence of significant reversal (momentum) of cumulative returns divided by total number of occurrence of large price changes near market opening and closing, respectively.

4.4 Tests Incorporating Systematic Risk

4.4.1 Time-Varying Risks

The above model does not incorporate changes in systematic risk. To account for the abnormal returns and potential effects of time-varying risk on returns of commodity futures, I employ a multifactor model, which is based on the study by Miffre and Rallis (2007):

$$R_{i,t} = \alpha_i + \beta_b\left(R_{bond,t} - R_{f,t}\right) + \beta_s\left(R_{S\&P,t} - R_{f,t}\right) + \beta_g\left(R_{GSCI,t} - R_{f,t}\right) + \varepsilon_{i,t}, \qquad (4)$$

[14] Cox and Peterson (1994) show significant overreaction for days 1 through 3, consistent with findings of Atkins and Dyl (1990) and Bremer and Sweeney (1991). In addition, as time passes, overreaction tends to be weaker.

where $R_{bond,t}$, $R_{S\&P,t}$, $R_{GSCI,t}$ are the returns on the government bond index, the S&P 500 composite index and GSCI, respectively, and $R_{f,t}$ is the risk free rate; $R_{i,t}$ is the logarithm returns of commodity futures i at day t. If parameters β_b , β_s, β_g are significant, it suggests that returns can be explained by price movements in the bond market, equity market and commodity market. In addition, since abnormal returns would be captured by alpha term and changes in beta before and after shock; to test whether parameters β_b , β_s, and β_g change significantly, I form a model as follows:

$$R_{i,t} = \alpha_i + \beta_b\left(R_{bond,t} - R_{f,t}\right)D + \beta_s\left(R_{S\&P,t} - R_{f,t}\right)D + \beta_g\left(R_{GSCI,t} - R_{f,t}\right)D + \varepsilon_{i,t} \tag{5}$$

where D is a dummy variable that takes value of 1 for post-shock period, and 0 for pre-shock period. The parameter α_i represents price reactions after controlling for systematic risk for commodity futures i. A significant change in beta from F-test would suggest abnormal returns.

4.4.2 Market Conditions

The above model does not incorporate changes in economic environments. To account for potential effect of market conditions, I divide my sample into two periods: economic environments-expansionary and recessionary periods, based on NBER definition,[15] and examine whether returns respond asymmetrically to price movements in the bond market, equity market and commodity market in each of these environments. The model is specified as follows:

[15] See www.nber.org/cycles.

$$R_{i,t} = \alpha_i + \beta_b(R_{bond,t} - R_{f,t})D + \beta_s(R_{S\&P,t} - R_{f,t})D + \beta_g(R_{GSCI,t} - R_{f,t})D + \varepsilon_{i,t} \quad (6)$$

where D is a dummy variable that takes value of 1 for expansionary periods, and 0 for recessionary periods. If parameters β_b , β_s, and β_g are significantly, it suggests that in expansionary environment returns are significantly different from that in the recessionary environment.

4.4.3 Business Cycle

As another extension of Eq. (4), an alternative model incorporates the effects of business cycle; the variables to proxy for business cycle include the dividend yield on the S&P 500 composite index, the term structure of interest rates, and the default spread (Chordia and Shivakumar, 2002). The dividend yield on the market is defined as the total dividend payments to the Center for Research in Security Prices (CRSP) Value-weighted index over the previous 12 month divided by the current level of the index. The default spread is defined as the difference between the average yield of bonds rated BAA by Moody's and the average yield of bonds with a Moody's rating of AAA, and is included to capture the effect of default premiums. The term structure is measured as the difference between the average yield of Treasury bonds with more than 10 years to maturity and the average yield of T-bill that mature in three month; Fama and French (1988) show the term structure is closely related to short-term business cycle, and default spread tracks long-term business cycle conditions.

The model is specified as

$$R_{i,t} = \alpha_i + \gamma_i Z_{i,t-1} + \beta_{b0}(R_{bond,t} - R_{f,t}) + \beta_{b1}(R_{bond,t} - R_{f,t})Z_{i,t-1} + \beta_{s0}(R_{S\&P,t} - R_{f,t}) + \beta_{s1}(R_{S\&P,t} - R_{f,t})Z_{i,t-1} + \beta_{g0}(R_{GSCI,t} - R_{f,t}) + \beta_{g1}(R_{GSCI,t} - R_{f,t})Z_{i,t-1} + \varepsilon_{i,t} \tag{7}$$

where $Z_{i,t-1}$ includes proxies for business cycle such as the dividend yield on the S&P 500 composite index, the term structure of interest rates and default spread. I use the post-shock CARs obtained from Eq. (2) to check whether the returns will change after incorporating business cycle. A significant γ would indicate that business cycle can explain some portion of cumulative returns of commodity futures.

5.Empirical Evidence

5.1 Summary Statistics

Table 2 presents the summary statistics about positive and negative price changes in both opening and closing. I classify the commodity futures into five categories, namely, energy, metal, food (non-grains), grains, and livestock. When a positive (negative) price shock is defined as one where return on a particular day is above (below) two standard deviations, the number of price shocks usually is smaller than that of a daily return of 5% (-5%) but above 10% (-10%). On average, the number of large price changes is larger in the opening than in the closing, except for coffee, cocoa, and orange juice that are associated with slightly more large price changes near closing. This may suggest that for food (non-grains) contracts, prices are more sensitive to trading noise during the trading hours. Most commodity futures exhibit more

Table 2

Summary Statistics of Positive and Negative Shocks in Commodity Futures Markets

The day of positive (negative) price shock, i.e. the event day 0, is initially defined as one where a daily return is 5% or more (-5% or less). Then I verify the results with different definitions: 10% (-10%), 15%(-15%). I also define a positive (negative) price shock as one where the return on a particular day is above (below) two standard deviations (2STD) the average market daily return computed over [-60 to -11] days relative to the day of the price shock. To avoid compounding effects, shocks that follow within 10 days of a given event day is excluded in this analysis.

	Opening								Closing							
Commodity Futures	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD
A: Energy																
Crude oil (CO)	234	180	105	92	65	52	167	121	231	180	132	91	70	51	165	121
Heating oil (HO)	292	156	142	105	76	57	153	110	190	158	137	121	78	57	154	105
Natural gasoline (NA)	216	172	108	93	102	75	127	61	215	169	106	94	99	74	99	63
B: Metals																
Gold (G)	199	110	84	55	45	23	148	129	127	137	74	50	50	20	117	108
Copper (C)	321	191	121	35	66	35	174	185	221	189	117	105	68	36	176	182
Silver (S)	301	250	189	102	96	46	224	164	299	248	183	94	93	46	165	155
Palladium (P)	270	219	165	120	104	61	184	126	265	217	164	115	103	58	193	163
Platinum (PL)	298	227	144	98	68	31	232	164	297	220	135	97	66	32	227	172
Lumber (L)	306	299	181	147	97	60	205	158	303	293	184	142	95	60	129	170
C: Foods (non-grains)																
Cocoa (CC)	296	302	186	136	101	46	145	133	302	304	189	136	105	49	214	192
Coffee (CF)	198	167	83	66	54	34	111	97	200	167	89	76	76	44	121	99
Cotton (CT)	299	256	145	119	74	47	248	176	300	254	147	120	75	45	251	195
Orange juice (OJ)	305	327	168	163	91	53	200	224	306	329	173	166	98	55	203	221
Sugar (SU)	357	356	240	229	163	136	228	195	357	354	247	228	162	136	227	128
D: Grains																
Corn (CR)	245	201	175	156	98	47	201	187	221	196	154	132	78	34	187	145
Kansas city wheat (KW)	222	206	100	51	46	20	187	167	223	203	97	54	45	19	189	146
Minnesota wheat (MW)	165	136	74	45	38	20	148	139	161	131	76	44	36	18	184	145
Oats (O)	342	321	191	139	101	51	224	183	334	322	190	136	100	46	220	193
Wheat (W)	308	287	158	113	81	32	225	195	305	287	162	112	82	32	228	185
Soybean oil (SO)	315	290	177	130	92	56	221	180	312	292	180	133	96	53	226	184
Soybean meal (SM)	311	256	160	110	88	50	234	175	311	259	156	111	81	51	237	174
Soybeans (SOY)	298	239	138	110	76	46	247	176	300	231	135	106	75	42	243	228
E:Livestock																

Table 2
Continued

	Opening								Closing							
Commodity Futures	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD
Feeder cattle (FC)	207	157	60	47	17	12	205	172	202	161	59	47	17	9	210	185
Live cattle (LA)	256	216	87	66	26	20	224	190	254	214	89	61	25	19	223	207
Live hogs (LH)	360	336	234	182	125	86	230	207	358	333	232	182	122	79	235	218
Pork bellies (PB)	363	366	239	237	161	130	201	218	358	363	240	233	165	127	197	202

positive price changes than negative price changes, except that, in the food (non-grains) category and livestock category, cocoa, orange juice, and pork bellies have more negative price changes than positive price changes at 5% (-5%) and 2STD (-2STD). This may indicate that for these three commodities, there are more announcements of bad news or investors are more risk averse to bad news. In addition, feeder cattle and live cattle have the lowest ratio of large price changes, when large price changes are defined as 15% (-15%) to large price changes at 5% (-5%), which suggest that prices in these two commodities are relatively stable and investors are less liable to respond extremely to news in these two commodities.

5.2 Identifying Price Patterns

Table 3 presents the results of the regression analysis for factors that might affect large price changes at 5% (-5%). The dependent variable equals 1 if there is a large price changes, and independent variables include a set of variables: opening dummy variable, that equals 1 for price changes in the opening, 0 otherwise; and monthly dummy variables that proxy seasonality effect on large price changes; as well as the maturity effect, which is supposed to be negatively related to large price changes. I classify the commodity futures into five. Appendix A presents the similar price patterns for large price changes at 10% (-10%), 15% (-15%), and 2STD (-2STD).

As stated in the introduction, an expected result is that large price changes are more likely to occur in the opening because announcements of macroeconomic news are more likely to cause large price changes than trading noise. As shown in Table 3, for most commodity futures, the coefficient of open dummy variables is positively significant, which implies that announcements in the morning are more likely to cause large price changes. The exceptions include coffee, cocoa, and orange juice, for which the coefficients are negative, suggesting trading noise during the day may better explain large price changes near the closing, which is consistent with Table 2 that shows a slightly greater number of large price changes near closing than opening for these three food futures.

Based on the Samuelson's hypothesis, large price changes are more likely to occur as the maturity gets closer. That is, time-to-maturity is expected to be negatively related to large price changes, suggesting that the volatility increases as the futures approach to maturity. On average, there is a significant negative effect of maturity on large price changes, which suggests that when information arrives more frequently near the maturity; investors are more likely to respond to such information, inducing a greater likelihood of large price changes. However, consistent with results by Duong and Kalev (2006), there is less support for Samuelson hypothesis for metal and energy futures, but strong support for food (non-grains), grains, and livestock futures. The findings may suggest that information arrives relatively stable during the whole contract period for metal and energy. Based on argument of Bessembinder, Coughenour, Seguin, and Smeller (1996), this may also suggest Samuelson hypothesis is more likely to be supported in those markets that exhibit a negative covariance between spot price changes and changes in net carry costs.

With regard to seasonal effects, seasonal effect is significant for some commodity futures; however, such effects vary across commodities. In the energy category, the coefficients for the months July through the turn-of the year tend to be larger and significant. This might be explained by greater uncertainty in supply/demand for crude oil, heating oil, and natural gasoline during hot weather (July through September) and cold weather (such as January). In the food (non-grains) category, the coefficients tend to be larger in the summer months. Since the summer months are also the production season of cotton, coffee and cocoa, the greater likelihood of supply/demand imbalance in summer might explain more occurrences of large price changes in July and August. In grains category, the results indicate that corn has more price volatility during the harvest season (September) and wheat has more 'large' price changes in harvest season (July and August) and planting season (May and June); for all soy products, large price changes are more likely to occur in January, the harvest season; for oats, a greater number of large price changes occur in September through November; for livestock, more large price changes occur in July and August, when there might be greater demand/supply; in the metal category, and in precious metal, generally there is much weaker seasonal effects.

Table 3

Price Patterns

This table reports results for effect of information, maturity effect and seasonal effect on large price changes at 5% (-5%). The dependent variable equals 1 if large price changes occur at day t for commodity futures i, 0 if no large price changes occur at day t for commodity futures i, OPEN is a dummy variable that takes the value of 1 for price changes at the opening, 0 otherwise. I also include 11 dummy variables that proxy seasonal effects, namely, *JAN_D, FEB_D, MAR_D, APR_D, MAY_D, JUN_D, JUL_D, AUG_D, SEP_D, OCT_D, and NOV_D. JAN_D* takes value of 1 for price changes in January, 0 otherwise. The similar definition is applied to other 10 monthly dummy variables. The variable *Mat* is the number of days to maturity. The model is specified as: $Y_{it} = \alpha_1 + \alpha_2 OPEN\_D_{it} + \alpha_3 JAN\_D_{it} + \alpha_4 FEB\_D_{it} + \alpha_5 MAR\_D_{it} + \alpha_6 APR\_D_{it} + \alpha_7 MAY\_D_{it} + \alpha_8 JUN\_D_{it} + \alpha_9 JUL\_D_{it} + \alpha_{10} AUG\_D_{it} + \alpha_{11} SEP\_D_{it} + \alpha_{12} OCT\_D_{it} + \alpha_{13} NOV\_D_{it} + \alpha_{14} \ln Mat_{it} + \varepsilon_{it}$. The asterisks ***,** and * indicate significance at 1%, 5% and 10%, respectively.

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
A:Energy														
CO	0.142	0.042	0.015	0.018	-0.001	-0.005	-0.002	-0.008	0.016	0.030	0.021	0.025	-0.003	-0.002
	(***)	(**)	(*)	(**)					(**)	(***)	(***)	(***)		(*)
HO	0.111	0.043	0.011	0.005	-0.011	-0.004	-0.005	-0.006	0.004	0.015	0.016	-0.007	-0.004	-0.001
	(***)	(**)	(*)							(*)	(**)			
NG	0.085	0.067	0.028	0.009	0.003	0.006	0	0.001	0.002	0.001	0.008	0.008	0.017	-0.001
	(***)	(***)	(***)										(**)	
B:Metal														
G	0.032	0.042	0.003	0.008	-0.010	-0.009	0.013	-0.007	-0.008	-0.015	0.000	-0.001	0.000	-0.005
	(*)	(**)					(*)			(*)				(*)
C	0.084	0.053	0.013	0.001	0.002	-0.002	0.003	0.014	0.013	0.000	0.008	0.002	0.007	-0.006
	(***)	(***)						(*)						(**)
S	0.057	0.054	-0.002	0.004	-0.007	-0.008	0.014	-0.004	-0.008	-0.001	-0.007	-0.009	0.003	-0.003
	(***)	(***)					(*)							(*)
P	0.076	0.056	0.002	0.002	0.003	0.003	0.005	0.003	-0.008	0.001	-0.002	-0.005	0.001	-0.003
	(***)	(***)												(*)
PL	0.027	0.098	0.000	0.003	-0.002	0	-0.002	0.003	0	-0.008	-0.004	-0.002	0	-0.010
		(***)												(**)
L	0.103	0.034	0.011	-0.002	-0.006	-0.003	0.000	-0.004	-0.010	0.005	0.013	0.012	0.005	-0.008
	(***)	(**)	(*)								(*)	(*)		(**)
C: Food (non-Grains)														
CC	0.053	-0.041	0.005	0.006	0.003	0.006	0.014	0.008	0.011	0.018	0.009	-0.001	0.002	-0.015
	(***)	(**)							(*)	(**)				(***)
CF	0.082	-0.046	0.006	0.006	0.006	-0.000	0	0.008	0.010	0.030	0.010	0.002	0.004	-0.015
	(***)	(**)							(*)	(***)	(*)			(***)

Table 3
Continued

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
CT	0.076 (***)	0.024 (*)	0	-0.009	-0.000	-0.003	0.002	0.016 (**)	0.019 (**)	0.011 (**)	-0.009	-0.016	-0.003	-0.014 (***)
OJ	0.087 (***)	-0.026 (*)	0.003	0.006	-0.009	-0.002	-0.004	-0.006	0.001	0.001	-0.005	0.018 (**)	0.022 (***)	-0.013 (***)
SU	0.042 (**)	0.025 (*)	0.019 (**)	0.006	0.005	0.009	0.009	0.009	0.009	0.005	0.021 (***)	0.005	0	-0.007 (**)
D: Grains														
CR	0.106 (***)	0.024 (*)	-0.008	-0.004	0	0.002	0.005	0.003	0.005	0.003	0.012 (*)	0.009	0.008	-0.013 (***)
KW	0.104 (***)	0.029 (*)	0.006	0.012	0.011	0.001	0.021 (***)	0.020 (**)	0.025 (***)	0.035 (***)	0.001	0.006	0.007	-0.018 (***)
MW	0.123 (***)	0.051 (***)	0.003	0.009	0.010	0.002	0.016 (**)	0.030 (***)	0.031 (***)	0.041 (***)	0.008	0.006	0.002	-0.017 (***)
O	0.383 (***)	0.088 (***)	-0.009	-0.006	0.006	0.005	0.000	0.005	0.005	0.003	0.064 (***)	0.035 (***)	0.031 (**)	-0.005 (*)
W	0.056 (***)	0.027 (*)	0.006	0.005	0.004	0.007	0.021 (***)	0.022 (***)	0.027 (***)	0.028 (***)	0.006	0.003	0.002	-0.004 (*)
SO	0.077 (***)	0.065 (***)	0.014 (*)	-0.008	0.003	0.003	0.007	0.009	0.007	0.002	0.002	0.008	0.006	-0.002 (*)
SM	0.083 (***)	0.043 (**)	0.022 (***)	0.002	-0.003	0.009	-0.001	0.002	0.007	0.006	0.005	0.007	-0.002	-0.009 (**)
SY	0.086 (***)	0.046 (**)	0.013 (*)	-0.010	-0.003	0.008	-0.010	0.006	0.009	0.020	0.001	0.010	0.004	-0.007 (**)
E:Livestock														
FC	0.026	0.110 (***)	0.009	0.010	0.004	0.006	0.007	0.005	0.017 (**)	0.004	0.004	0.000	0.004	-0.011 (***)
LC	0.017	0.057 (***)	0.010	0.008	0.004	0.001	0.006	0.006	0.018 (**)	0.014 (*)	0.010	0.004	0	-0.007 (**)
LH	0.063 (***)	0.063 (***)	-0.005	-0.010	0.005	0.003	0.000	-0.001	0	0.013 (*)	-0.007	0.002	0.001	-0.012 (***)
PB	0.036 (*)	0.064 (***)	0.001	0.010	0.002	0.006	0.009	0.005	0.017 (**)	0.016 (**)	0.012 (*)	0.005	0.001	-0.010 (**)

In sum, Table 3 results are generally in line with my expectations: in general, large price changes of commodity futures are more likely to be caused by announcements of macroeconomic news, and there is evidence supporting the maturity effect and seasonal effect; however, the seasonal and maturity effects are less significant in energy and metal futures.

5.3 Effects of Large Price Changes

To examine whether there is a greater probability of reversal following closing price changes than opening prices, I investigate the average cumulative returns after shocks. Figures 1, 2, 3, and 4 present the average cumulative returns following positive and negative large price changes in both opening and closing for all commodity futures at each definition of large price changes. Figures 5, 6, 7, and 8 present the probability of reversal following large price changes in both opening and closing at each definition of large price changes. The summary statistics from Figure 1 to Figure 8 are presented in Table 4.

The table shows that there is a tendency for price reversals following large price changes; the reversal occurs from the first day after shock and in general continues as we extend our estimation period. This reversal pattern is especially true at 10% (-10%) and 15% (-15%). At -5%, reversal disappears from second day in the opening and third day in the closing. For -2STD level, reversal disappears from third day in the opening and second day in the closing. This result supports the overreaction theory that the more extreme initial price movement is, the greater the subsequent adjustment. Table 4 also gives the estimates of the probability of reversal. Probabilities of reversal might provide a more clear comparison between reversals following positive price changes and negative large price changes in both opening and closing. I expect large price changes in closing will induce more reversals than large price changes in opening. The rationale for this argument is that large price changes near closing are more likely caused by trading noise, and therefore more likely to be followed by reversals.

On average, there is higher occurrence of reversal following large price change in closing than in opening. For example, at 5%, the probability of reversal of $ACAR_1$ is 49.653% following large price changes in opening, while the probability is 51.069% following large price changes in closing. This suggests that since large price changes near closing are more likely caused by noise trading.

It is plausible that negative price changes will induce more reversals than positive price changes. At 5% (-5%), the probability of reversal of $ACAR_1$ is 49.653% following positive price change in opening, while 50.311% following negative price changes in opening. This patterns holds for other $ACAR_t$ at other definitions of large price changes. Therefore, the results support asymmetric responses to news.

There are also some interesting findings regarding reversal of different commodity futures. Table 5 presents the results of probability of reversal at the first day following large price changes in opening for five futures categories. In general, metal and energy have a lower probability of reversal following large price changes. This is especially true for gold, for which the probability of reversal is around 11.098% (not shown in the table). Moreover, large probability of reversal is found in food (non-grains) and grains. The results suggest that participants in the food (non-grains) and grain markets tend to overreact to new information,

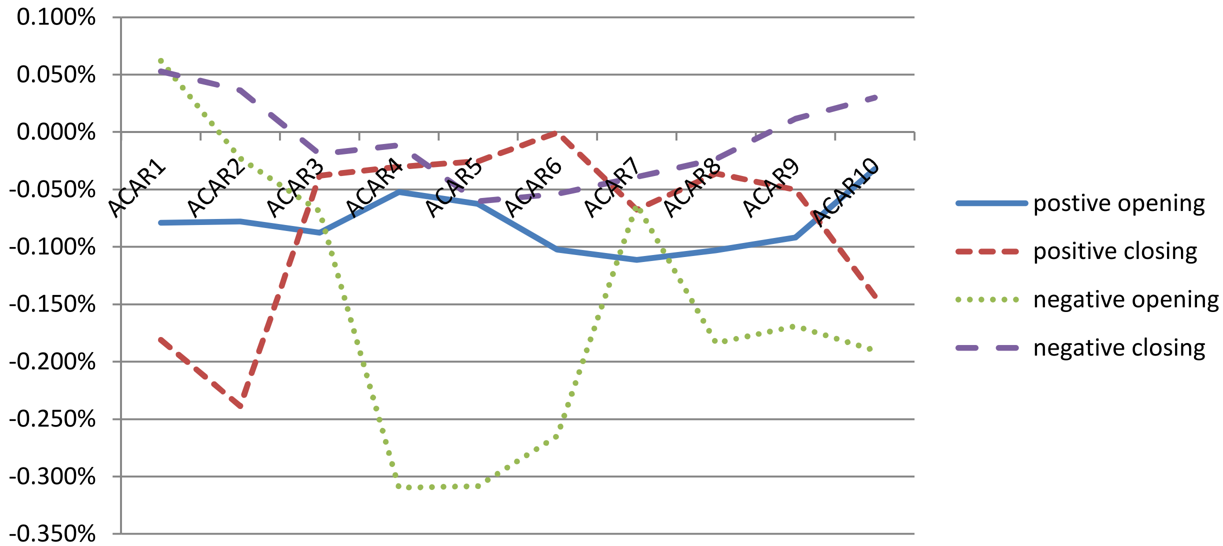

Figure 1 ACARs Following Large Price Changes in Both Opening and Closing at 5% and -5%

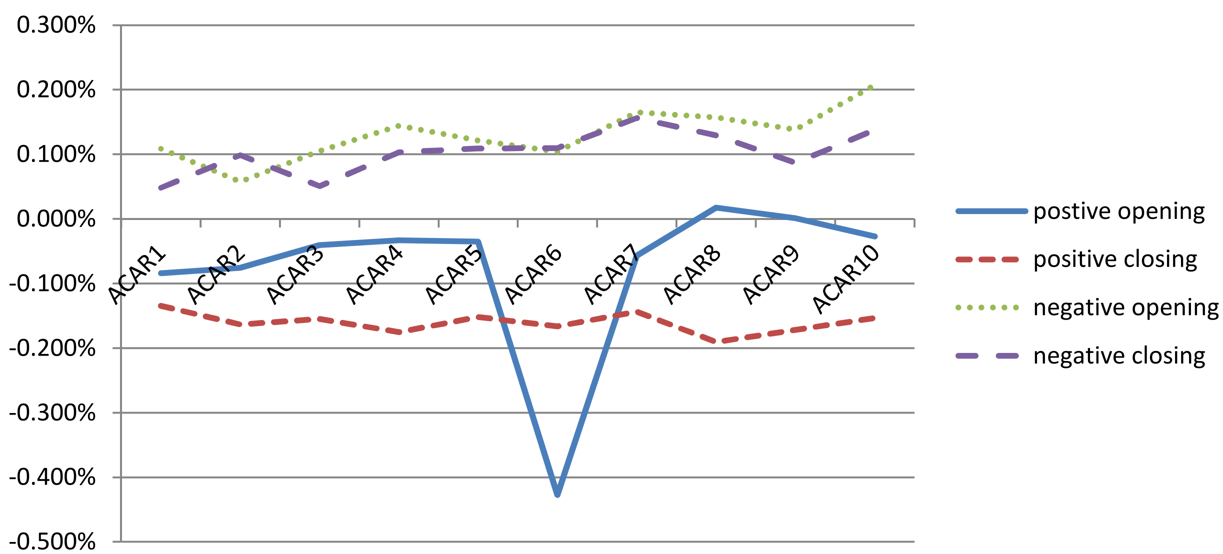

Figure 2 ACARs Following Large Price Changes in Both Opening and Closing 10% and -10%

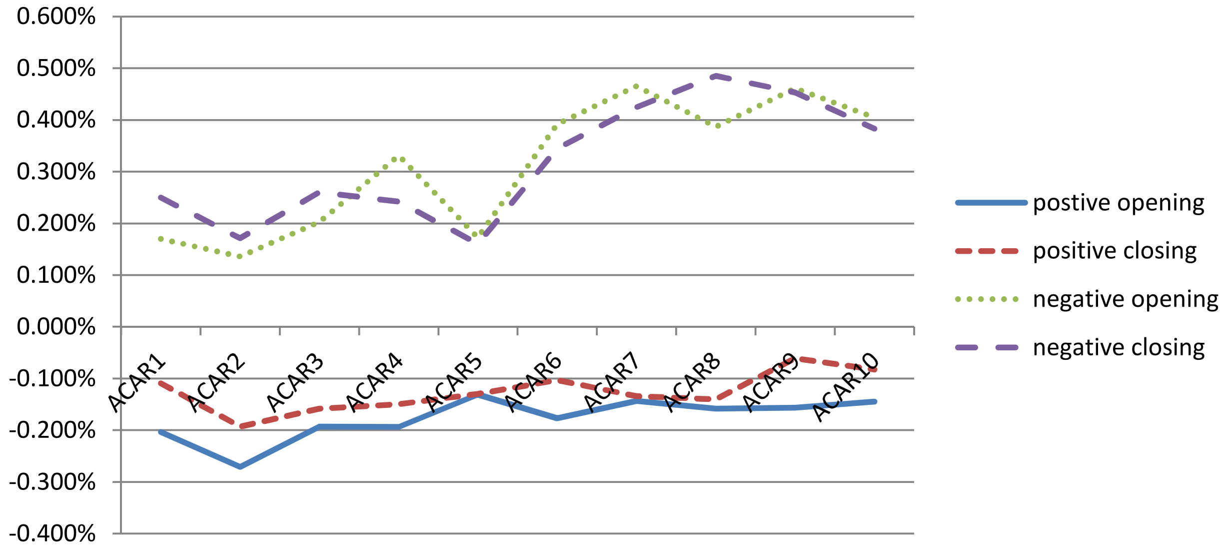

Figure 3 ACARs Following Large Price Changes in Both Opening and Closing at 15% and -15%

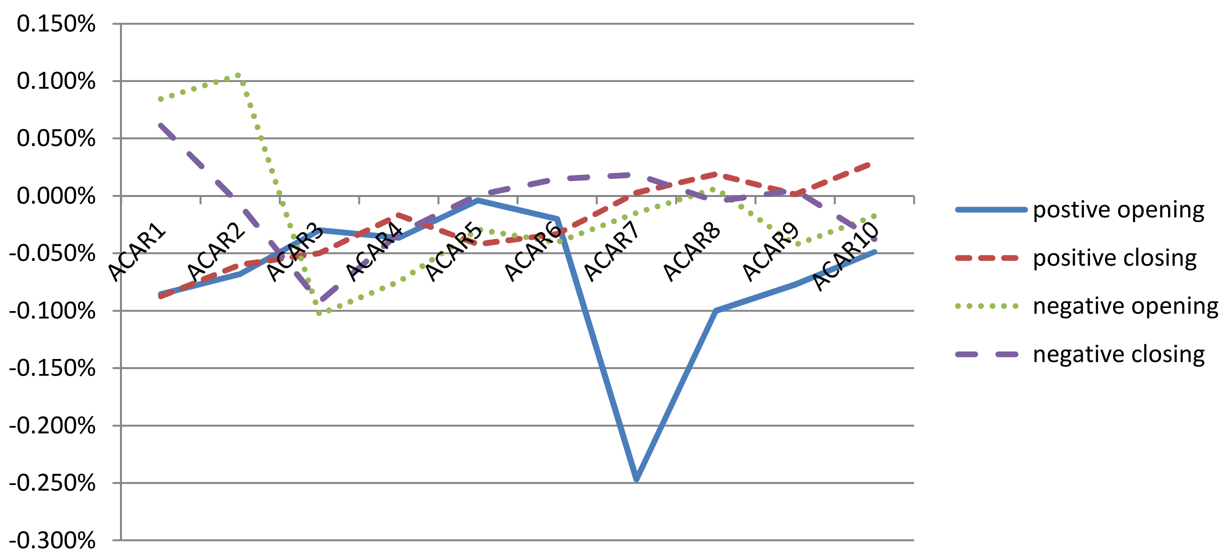

Figure 4 ACARs Following Large Price Changes in Both Opening and Closing at 2STD and -2STD

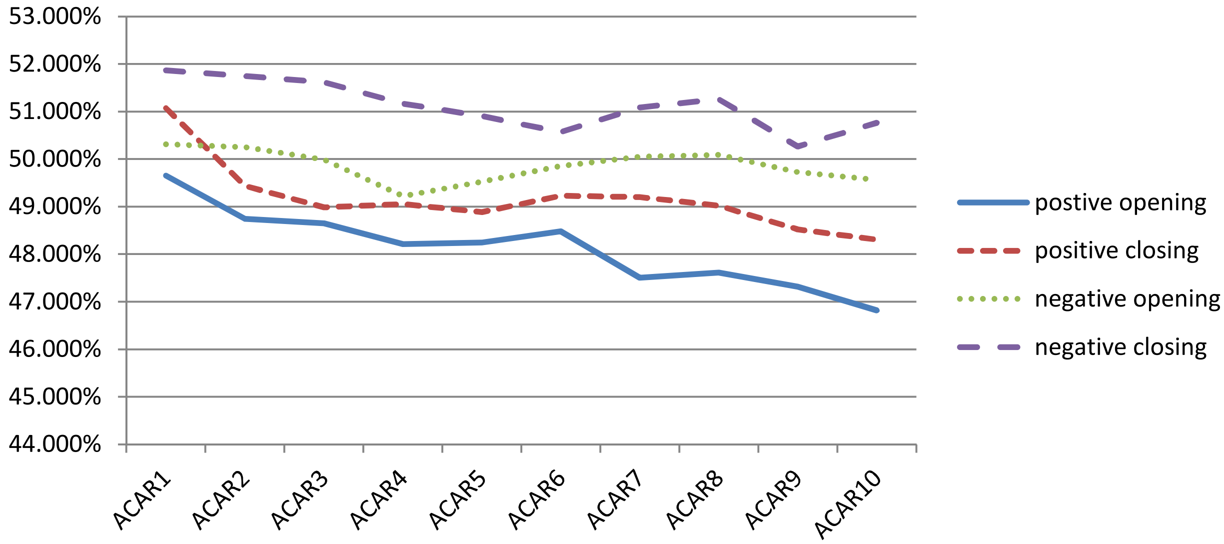

Figure 5 Probability of reversal Following Large Price Changes in Both Opening and Closing at 5% and -5%

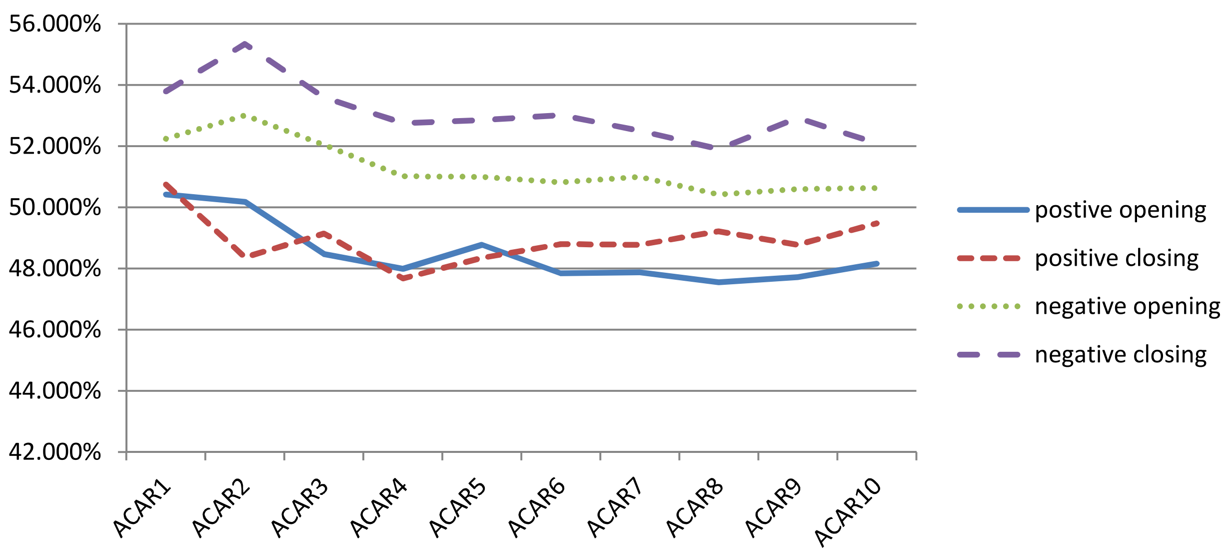

Figure 6 Probability of reversal Following Large Price Changes in Both Opening and Closing at 10% and -10%

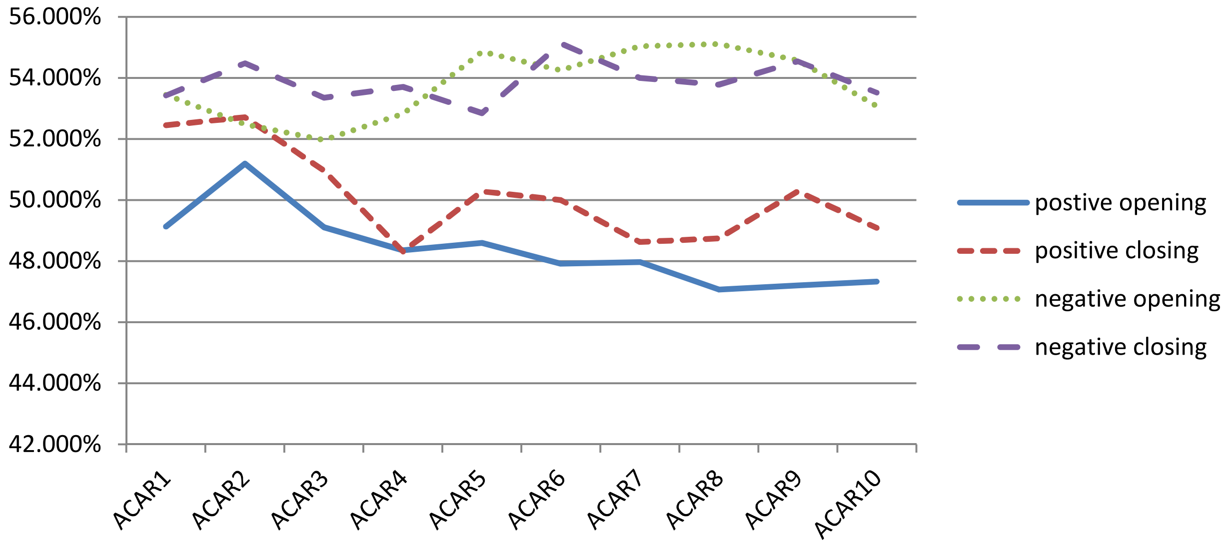

Figure 7 Probability of reversal Following Large Price Changes in Both Opening and Closing at 15% and -15%

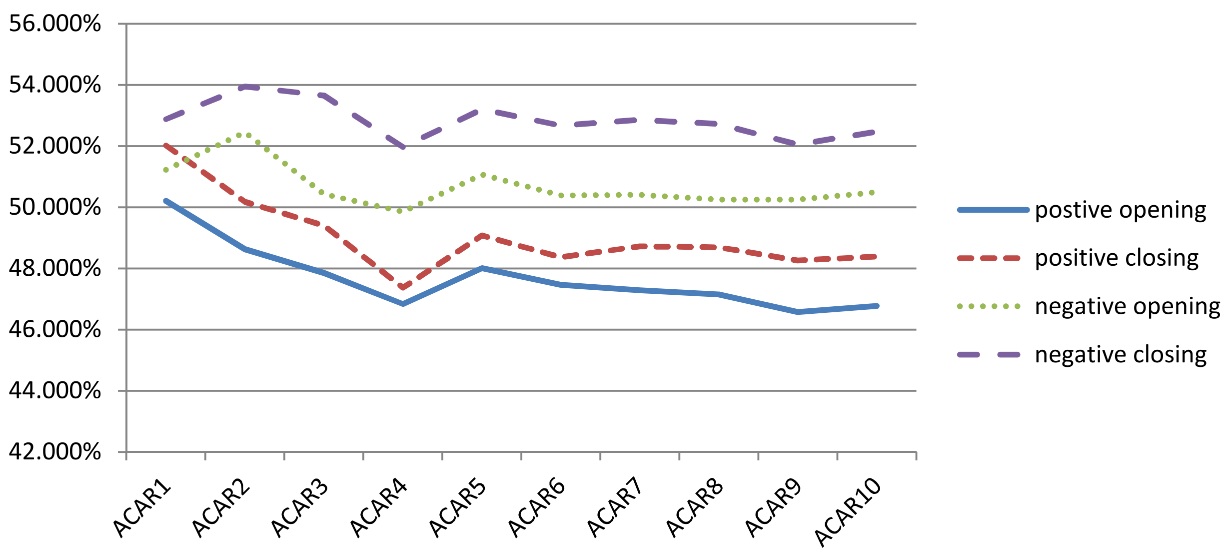

Figure 8 Probability of reversal Following Large Price Changes in Both Opening and Closing at 2STD and -2STD

Table 4

Commodity Price Reaction to Shocks: Mean-Adjusted ACARs

The mean adjusted average cumulative abnormal returns (ACARs) are estimated using Eq.(3). ACAR1 are the abnormal returns one day after the shock. ACAR2, ACAR3, …, ACAR10 are the average abnormal returns over the [0,2], [0,3],…, [0,10] windows after the shock. The asterisks ***,** and * indicate significance at 1%, 5% and 10%, respectively. The table presents mean(μ),variability of ACARs(σ), as well as the probability of reversal(P) across all commodity futures.

	ACAR1	ACAR2	ACAR3	ACAR4	ACAR5	ACAR6	ACAR7	ACAR8	ACAR9	ACAR10
Panel A: ACARs following positive shocks(5%) in opening price										
μ	-0.079%***	-0.078%***	-0.088%***	-0.052%***	-0.063%***	-0.102%***	-0.111%***	-0.103%***	-0.092%***	-0.032%**
σ	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.001%	0.001%	0.002%
P	49.653%	48.740%	48.647%	48.211%	48.243%	48.480%	47.506%	47.609%	47.318%	46.821%
Panel B: ACARs following positive shocks(5%) in closing price										
μ	-0.181%***	-0.239%***	-0.038%**	-0.030%*	-0.026%*	-0.001%	-0.068%***	-0.036%**	-0.050%**	-0.143%***
σ	0.007%	0.007%	0.000%	0.000%	0.000%	0.000%	0.001%	0.000%	0.001%	0.004%
P	51.069%	49.437%	48.982%	49.051%	48.883%	49.229%	49.201%	49.019%	48.524%	48.306%
Pane C: ACARs following negative shocks(-5%) in opening price										
μ	0.062%***	-0.023%*	-0.069%***	-0.310%***	-0.308%***	-0.265%***	-0.063%***	-0.184%***	-0.169%***	-0.190%***
σ	0.000%	0.001%	0.002%	0.012%	0.011%	0.011%	0.002%	0.011%	0.011%	0.012%
P	50.311%	50.254%	49.985%	49.222%	49.523%	49.851%	50.051%	50.089%	49.726%	49.562%
Panel D: ACARs following negative shocks (-5%) in closing price										
μ	0.053%***	0.036%**	-0.019%*	-0.012%*	-0.060%***	-0.054%***	-0.039%**	-0.024%*	0.012%*	0.030%*
σ	0.000%	0.000%	0.002%	0.001%	0.001%	0.001%	0.002%	0.002%	0.001%	0.001%
P	51.869%	51.746%	51.614%	51.168%	50.901%	50.570%	51.086%	51.261%	50.263%	50.765%
Panel E: ACARs following positive shocks(10%) in opening price										
μ	-0.084%***	-0.076%***	-0.041%**	-0.033%**	-0.035%**	-0.427%***	-0.057%***	0.017%**	0.001%	-0.027%*
σ	0.000%	0.000%	0.000%	0.000%	0.000%	0.025%	0.001%	0.001%	0.001%	0.001%
P	50.415%	50.176%	48.466%	47.989%	48.774%	47.843%	47.873%	47.545%	47.712%	48.155%
Panel F: ACARs following positive shocks(10%) in closing price										
μ	-0.135%***	-0.163%***	-0.155%***	-0.175%***	-0.152%***	-0.167%***	-0.144%***	-0.191%***	-0.172%***	-0.154%***
σ	0.007%	0.007%	0.005%	0.007%	0.007%	0.007%	0.007%	0.008%	0.008%	0.007%
P	50.738%	48.365%	49.133%	47.670%	48.339%	48.796%	48.774%	49.209%	48.773%	49.473%

Table 4
(Continued)

	ACAR1	ACAR2	ACAR3	ACAR4	ACAR5	ACAR6	ACAR7	ACAR8	ACAR9	ACAR10
Panel G: ACARs following negative shocks(-10%) in opening price										
μ	0.109%***	0.057%***	0.105%***	0.144%***	0.121%***	0.104%***	0.165%***	0.157%***	0.138%***	0.207%***
σ	0.000%	0.000%	0.000%	0.000%	0.001%	0.001%	0.000%	0.001%	0.001%	0.001%
P	52.233%	53.000%	52.035%	51.014%	50.990%	50.812%	50.992%	50.411%	50.590%	50.624%
Panel H: ACARs following negative shocks(-10%) in closing price										
μ	0.048%**	0.098%***	0.050%**	0.103%***	0.109%***	0.109%***	0.156%***	0.129%***	0.087%***	0.138%***
σ	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.001%	0.000%	0.001%
P	53.785%	55.331%	53.585%	52.754%	52.847%	53.015%	52.500%	51.905%	52.916%	52.087%
Panel I: ACARs following positive shocks(15%) in opening price										
μ	-0.203%***	-0.271%***	-0.193%***	-0.193%***	-0.131%***	-0.177%***	-0.144%***	-0.158%***	-0.156%***	-0.145%***
σ	0.000%	0.000%	0.001%	0.002%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
P	49.127%	51.194%	49.101%	48.352%	48.588%	47.912%	47.965%	47.069%	47.204%	47.323%
Panel I: ACARs following positive shocks(15%) in closing price										
μ	-0.109%***	-0.193%***	-0.158%***	-0.150%***	-0.129%***	-0.103%***	-0.134%***	-0.141%***	-0.061%***	-0.083%***
σ	0.000%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
P	52.442%	52.705%	50.961%	48.307%	50.282%	49.995%	48.620%	48.744%	50.281%	49.085%
Panel J: ACARs following negative shocks(-15%) in opening price										
μ	0.170%***	0.136%***	0.203%***	0.331%***	0.173%***	0.392%***	0.465%***	0.387%***	0.461%***	0.405%***
σ	0.001%	0.001%	0.002%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.003%
P	53.441%	52.477%	51.969%	52.821%	54.851%	54.248%	55.027%	55.108%	54.569%	53.070%
Panel K: ACARs following negative shocks(-15%) in closing price										
μ	0.250%***	0.171%***	0.260%	0.242%***	0.161%***	0.345%***	0.425%***	0.485%***	0.453%***	0.383%***
σ	0.001%	0.001%	0.001%	0.002%	0.001%	0.001%	0.001%	0.002%	0.001%	0.002%
P	53.418%	54.472%	53.343%	53.698%	52.845%	55.125%	53.992%	53.778%	54.540%	53.510%
Panel L: ACARs following positive shocks(2STD) in opening price										
μ	-0.086%***	-0.068%***	-0.030%	-0.037%**	-0.004%	-0.020%*	-0.247%***	-0.100%***	-0.077%***	-0.049%**
σ	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.005%	0.001%	0.001%	0.001%
P	50.206%	48.620%	47.852%	46.836%	48.004%	47.466%	47.286%	47.145%	46.573%	46.769%

Table 4
(Continued)

	ACAR1	ACAR2	ACAR3	ACAR4	ACAR5	ACAR6	ACAR7	ACAR8	ACAR9	ACAR10
Panel M: ACARs following positive shocks(2STD) in closing price										
μ	-0.087%***	-0.060%***	-0.050%	-0.017%	-0.042%**	-0.033%**	0.003%	0.019%	0.001%	0.029%
σ	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%
P	52.014%	50.170%	49.401%	47.365%	49.076%	48.362%	48.722%	48.687%	48.258%	48.383%
Panel N: ACARs following negative shocks(-2STD) in opening price										
μ	0.084%***	0.106%***	-0.103%	-0.075%***	-0.029%**	-0.041%**	-0.015%	0.006%	-0.043%**	-0.018%
σ	0.000%	0.000%	0.002%	0.002%	0.002%	0.001%	0.002%	0.001%	0.001%	0.001%
P	51.220%	52.444%	50.424%	49.853%	51.067%	50.381%	50.408%	50.247%	50.245%	50.487%
Panel O: ACARs following negative shocks(-2STD) in closing price										
μ	0.061%***	-0.008%	-0.092%***	-0.033%***	0.001%	0.015%	0.019%	-0.005%	0.005%	-0.038%**
σ	0.000%	0.000%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%	0.001%
P	52.875%	53.945%	53.647%	51.962%	53.203%	52.662%	52.850%	52.721%	52.043%	52.468%

Table 5

Probability of Reversal in Five Commodity Categories

The probability of reversal is defined as the number of reversal divided by the number of large price changes. This table presents the probability of reversal at the first day following large price changes in opening for five commodity categories.

Futures	5%	-5%	10%	-10%	15%	-15%	2STD	2STD
Energy	51.864%	38.930%	52.015%	52.871%	51.152%	43.998%	50.917%	40.608%
Metal	42.724%	51.064%	43.369%	46.079%	43.698%	42.585%	43.772%	45.640%
Food(non-grains)	50.603%	51.781%	52.769%	56.042%	58.714%	61.265%	53.994%	54.925%
Grains	52.337%	54.052%	52.889%	56.526%	54.928%	59.877%	52.983%	55.805%
Livestock	51.831%	51.553%	52.273%	52.205%	53.714%	56.941%	51.009%	53.985%

creating a larger-than-appropriate effect on commodity prices. Similar results are found for reversal following large price changes in closing, presented in Appendix B.

The result for gold is consistent with the following. Based on futures-spot price formula, $F = Se^{(r+v-y)T}$, y is defined as convenience yield. For gold, convenience yield is least variable with other commodities (Dincerlaer, Khokher, and Simin, 2005); therefore, it implies lower overreaction and less probability of reversal. While for energy, the result is inconsistent with my expectation that energy is expected to have a higher reversal. In the energy market, commodities are severely affected by the market information, driving price far away from fundamentals; thereby, a larger probability of reversal is expected. Therefore, further research should focus on the energy market.

5.4. Tests Incorporating Systematic Risk

The analysis above does not incorporate the effects of common risk factors that might affect returns. Table 6 displays various models that adjust for the risk factors. First, to account for the potential effect of time-varying risk on returns of commodity futures, I employ a multifactor model including returns on GSCI, returns on bond market, and returns on S&P 500. Panel A of Table 6 displays the sensitivities of returns to the bond, equity, and commodity futures markets. The results indicate that returns of commodity futures are sensitive to the risk factors. The coefficients of α are insignificant, which suggests that the abnormal returns can be described as a compensation for exposure to the risks. In addition, in unreported results, F-test shows that there is an insignificant change in parameters β_b , β_s, and β_g before and after large price changes. Since abnormal returns would be captured by both α an changes in β, the results

Table 6 Tests Incorporating Systematic Risk

To account for the abnormal returns and potential effects of time-varying risk on returns of commodity futures, I employ a multifactor model, which is based on the study by Miffre and Rallis (2007): $R_{i,t} = \alpha_i + \beta_b(R_{bond,t} - R_{f,t}) + \beta_s(R_{S\&P,t} - R_{f,t}) + \beta_g(R_{GSCI,t} - R_{f,t,}) + \varepsilon_{i,t}$, where $R_{bond,t}$, $R_{S\&P,t}$, and $R_{GSCI,t}$ are the returns on the government bond index, the S&P 500 composite index and GSCI, respectively, and $R_{f,t}$ is the risk free rate. $R_{i,t}$ is the logarithm abnormal returns of commodity futures i at day t. Panel A presents the results for effect of return on GSCI, equity market, and bond market. In Panel B, I divide my sample into two periods: expansionary and recessionary periods, based on NBER definition to account for effect of market condition. Panel C, D, and E presents the effect of business cycle, namely, dividend yield on the S&P 500 composite index, term structure of interest rates (the difference between the average yield of treasury bonds with more than 10 years to maturity and the average yield of T-bill that mature in one month), and default spread (the difference between the average yield of bonds rated BAA by Moody's and the average yield of bonds with a Moody's rating of AAA). The model is specified as: $R_{i,t} = \alpha_i + \gamma_i Z_{i,t-1} + \beta_{b0}(R_{bond,t} - R_{f,t}) + \beta_{b1}(R_{bond,t} - R_{f,t})Z_{i,t-1} + \beta_{s0}(R_{bond,t} - R_{f,t}) + \beta_{s1}(R_{bond,t} - R_{f,t})Z_{i,t-1} + \beta_{g0}(R_{bond,t} - R_{f,t}) + \beta_{g1}(R_{GSCI} - R_{f,t})$ $Z_{i,t-1} + \varepsilon_{i,t}$, where $Z_{i,t-i}$ proxies business cycle. The asterisk *, **, and *** indicate 1%, 5%, and 10% significance levels.

	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD
Panel A: Returns on bond, equity, and commodity markets								
α	-0.001	0.001	0.001	0.002	0.001	0.005	-0.001	0.001
β_b	0.011***	0.002***	-0.001*	0.015***	-0.003*	0.000***	0.006***	-0.002***
β_s	-0.002***	-0.008**	0.029***	-0.042**	0.049***	0.066***	0.012***	-0.006***
β_g	0.012***	-0.004***	0.019***	0.021***	0.029***	-0.066***	0.012**	0.006*
Panel B: Market condition								
α	0.000***	-0.003	0.007*	-0.002	0.004*	-0.007*	0.009*	0.001
β_b	-0.050***	0.323**	-0.644***	0.339***	-0.431***	1.216***	-1.000***	0.005*
β_s	0.038**	-0.007***	0.016***	-0.026**	-0.065**	0.034*	-0.023**	-0.029***
β_g	-3.179*	0.965*	-1.608**	4.453***	6.551*	-4.603***	3.886***	3.351***
Panel C: Default spread								
α	0.000	-0.003	0.007	-0.002	0.004	-0.007	0.009	0.001
γ	-0.050***	0.323***	-0.644***	0.339**	-0.431*	1.216**	-1.000*	0.005***
β_{b0}	0.038***	-0.007***	0.016*	-0.026***	-0.065***	0.034***	-0.023***	-0.029***
β_{b1}	-3.179**	0.965***	-1.608***	4.453***	6.551**	-4.603**	3.886***	3.351**
β_{s0}	0.072***	-0.127***	0.243*	-0.445*	0.154*	-0.237***	0.124**	-0.165***
β_{s1}	-7.232**	12.589***	-20.370***	44.606***	-11.950***	33.002**	-10.818***	18.372*
β_{g0}	0.049***	-0.004**	0.008**	0.122**	0.086***	-0.029***	0.021*	0.049***
β_{g1}	-4.762*	0.277***	0.101***	-9.463*	-8.707***	-3.726***	-0.421***	-4.683**

Table 6
(Continued)

	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD
Panel D: Dividend Yield								
α	0.002	0.006	-0.005	0.006	-0.015	0.009	-0.005	0.004
γ	-0.203**	-0.331***	0.342***	-0.253**	0.900***	-0.255**	0.250***	-0.139***
β_{b0}	-0.012***	0.002*	-0.002*	0.016***	0.034***	-0.023***	0.016*	0.015*
β_{b1}	1.207***	-0.042***	0.072***	-0.082***	-1.993***	1.054*	-0.468*	-0.852***
β_{s0}	0.075**	0.091**	-0.027**	0.042***	-0.388*	-0.083***	0.081***	0.064**
β_{s1}	-4.504*	-5.405***	3.293***	-4.290*	25.252***	8.980*	-3.725**	-3.821**
β_{g0}	-0.082***	0.074*	-0.104*	0.107***	0.081*	0.217**	-0.151*	0.019***
β_{g1}	5.343***	-4.762**	7.013***	-5.363**	-2.916**	-16.997***	9.190**	-1.009*
Panel E: Term structure								
α	-0.001	0.001	0.001	0.005	0.004	0.003	-0.001	0.002
γ	-0.02***	-0.007**	-0.033**	-0.101***	-0.153*	0.060***	0.009	-0.019***
β_{b0}	0.001*	0.003*	-0.005***	0.022**	-0.037***	-0.020***	0.016***	0.005***
β_{b1}	0.493***	-0.024***	0.241*	-0.407***	1.841***	1.127***	-0.524**	-0.413**
β_{s0}	-0.010**	-0.030***	0.081***	-0.085***	0.146**	0.049***	0.058***	-0.049***
β_{s1}	1.000***	0.806*	-2.584***	2.688*	-4.776*	1.079**	-2.462*	2.622*
β_{g0}	0.004*	0.024***	-0.02***	0.117***	-0.006***	-0.118***	-0.018***	0.066***
β_{g1}	0.952**	-1.697**	2.137*	-3.908**	1.131**	2.513*	1.520***	-3.005*

suggest abnormal returns are insignificant. Second, to account for market condition, I use equation (6) that includes a dummy that takes the value of 1 for expansionary periods, and 0 for recessionary periods; the results for which are shown in Panel B. The abnormal returns after shocks, as represented by α, are significant, which implies that abnormal returns are significant even accounting for market conditions. Moreover, the significant coefficients on β_b , β_s , and β_g suggest that abnormal returns are significantly different in expansionary period and recessionary period. Panel C presents the result that incorporates the effect of dividend yield on S&P 500. It shows that abnormal returns are insignificant and dividend yield has an impact on returns ofcommodity futures. Such observation also holds for effect of default spread and term structure on return of commodity futures.

In sum, risks including returns on bond, equity, and commodity futures market, as well as the economic environment, and business cycle, can indeed explain returns on commodity futures. After accounting for these factors, there is no strong support for overreactions.

6.Conclusion

My study represents the first attempt to infer the causes and effects of large one-day price changes in commodity futures. The results indicate that announcements of macroeconomic news in the morning induce a greater number of large price changes. There is also evidence for seasonal effects; most commodity futures but metal futures show a significant seasonal effect. The maturity effect can explain large price changes mainly in grain, food (non-grains), and livestock futures. Weak maturity effect can be seen in metal and energy categories.

To examine the effects of large price change, I focus on the cumulative returns following the shock. Consistent with the overreaction theory, reversal occurs from first day after large price changes. The results show that more reversals occur in closing than in opening; since price changes occur after opening are more likely to be caused by trading noise thus greater chance of reversals, this result provides indirect evidence that trading noise is one important driver for price changes. However, further tests incorporating risk factors indicate no strong patterns following shocks.

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Appendix A:
Price Patterns

This table reports results for effect of information, maturity effect and seasonal effect on large price changes at 10% (-10%), 15% (-15%), and 2STD (-2STD). The dependent variable equals 1 if large price changes occur at day t for commodity futures i, 0 if no large price changes occur at day t for commodity futures i, OPEN is a dummy variable that takes the value of 1 for price changes at the opening, 0 otherwise. I also include 11 dummy variables that proxy seasonal effects, namely, *JAN_D, FEB_D, MAR_D, APR_D, MAY_D, JUN_D, JUL_D, AUG_D, SEP_D, OCT_D, and NOV_D. JAN_D* takes value of 1 for price changes in January, 0 otherwise. The similar definition is applied to other 10 monthly dummy variables. The variable *Mat* is the number of days to maturity and ε_{it} is an independently and identically distributed random disturbance with mean zero and finite variance, i.e. $\varepsilon \sim iid\ (0,\sigma^2)$. The model is specified as:

$$Y_{it} = \alpha_1 + \alpha_2 OPEN\_D_{it} + \alpha_3 JAN\_D_{it} + \alpha_4 FEB\_D_{it} + \alpha_5 MAR\_D_{it} + \alpha_6 APR\_D_{it} + \alpha_7 MAY\_D_{it} + \alpha_8 JUN\_D_{it} + \alpha_9 JUL\_D_{it} + \alpha_{10} AUG\_D_{it} + \alpha_{11} SEP\_D_{it}$$

$$+\alpha_{12} OCT\_D_{it} + \alpha_{13} NOV\_D_{it} + \alpha_{14} \ln Mat_{it} + \varepsilon_{it}$$ The asterisk *, **, and *** indicate 1%, 5%, and 10% significance levels.

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
Panel A: Price Shock 10%(-10%)														
A: Energy														
CO	0.108 (***)	0.045 (**)	0.015 (*)	0.019 (**)	-0.002	-0.010	-0.002	-0.002	0.019 (**)	0.028 (***)	0.027 (***)	0.025 (***)	-0.003	-0.002 (*)
HO	0.386 (***)	0.042 (**)	0.011 (*)	0.004	-0.006	-0.002	-0.003	-0.006	-0.006	0.021 (***)	0.020 (**)	0.003	0.002	-0.002 (*)
NG	0.079 (***)	0.022 (*)	0.029 (***)	-0.002	-0.005	-0.004	-0.002	-0.003	-0.004	0.008	0.009	-0.003	0.011 (*)	-0.001
B: Metal														
G	-0.010	0.068 (***)	0.010	0.009	0.001	-0.005	0.023 (***)	-0.002	0.002	-0.019 (**)	0.009	-0.000	0.004	-0.006 (**)
C	0.041 (**)	0.058 (***)	-0.002	-0.003	0	-0.009	-0.005	0.014 (**)	0.002	-0.005	-0.010	-0.005	0.002	-0.007 (**)
S	0.013	0.062 (***)	0.003	0.006	0	-0.00	0.014 (**)	0.010	0	-0.006	-0.002	0	-0.001	-0.005 (**)
P	0.040 (**)	0.076 (***)	-0.001	-0.001	-0.006	0	-0.010	-0.009	-0.002	0.001	0.014 (*)	0.001	-0.009	-0.007 (**)
PL	-0.026	0.103 (***)	0.006	0.001	0	-0.002	-0.001	0.005	-0.004	0	-0.003	0.005	0.001	-0.004 (*)
L	0.044 (**)	0.042 (**)	0.011 (*)	0.002	-0.004	0	0.006	0.010	0	0.006	0.014 (*)	0.012 (*)	0.002	-0.009 (*)
C: Food (non-grains)														

Appendix A
(Continued)

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
CC	-0.018	-0. 105 (**)	0.004	0.006	0.009	0.010	0.009	0.006	0.019 (**)	0.019 (**)	0.008	0	0.008	-0.013 (***)
CF	0.024	-0.046 (**)	0	0.011 (*)	0.001	-0.003	-0.011	0.003	0.012 (*)	0.017 (**)	0.029 (***)	0.001	0.002	-0.014 (***)
CT	0.030 (*)	0.031 (*)	0	-0.002	-0.001	0	0.002	0.017 (**)	0.013 (*)	0.025 (***)	-0.003	-0.008	-0.004	-0.011 (***)
OJ	0.052 (***)	-0.083 (***)	0.005	0.002	-0.001	-0.005	-0.010	-0.008	-0.006	-0.002	0.016 (**)	0.011 (*)	0.021 (***)	-0.003 (*)
SU	0.004	0.063 (***)	0.020 (**)	0.006	0.005	0.001	0.010	0.010	0.010	0.007	0.023 (***)	0.0075	-0.00	-0.010 (**)
D:Grains														
CR	0.062 (***)	0.041 (**)	0	0.005	0.001	0.006	0.006	0	0.002	0.004	0.023	0.001	0.010	-0.013 (***)
KW	0.083 (***)	0.033 (*)	-0.004	-0.002	0.005	0.009	0.022 (***)	0.028 (***)	0.032 (***)	0.035 (***)	0.007	0.010	-0.002	-0.019 (***)
MW	0.040 (**)	0.059 (***)	0	-0.002	-0.004	0.001	0.017 (**)	0.028 (**)	0.029	0.028 (***)	0.006	0.010	-0.001	-0.018 (***)
O	0.260 (***)	0.087 (***)	0	-0.007	-0.003	0.002	0.002	0.008	0.001	0.002	0.049 (***)	0.075 (***)	0.041 (***)	-0.004 (*)
W	0.045 (***)	0.031 (*)	-0.003	0.001	0.010	0.005	0.024 (***)	0.029 (***)	0.029 (***)	0.022 (***)	0.004	0.008	0.002	-0.006 **
SO	0.010	0.064 (***)	0.012 (*)	-0.003	0.007	0.007	0	0.001	0.003	0.007	0.008	0.002	0.008	-0.004 (*)
SM	0.046 (**)	0.041 (*)	0.026 (***)	0.007	0.003	0.004	0.001	0.001	0	0.010	0.010	0.004	0.005	-0.007 (**)
SY	0.027	0.072 (***)	0.020 (**)	0.002	0.003	0.002	0	0.010	0.001	0.009	0.010	0.010	0.006	-0.013 (***)
E: Livestock														
FC	0.019	0.110 (***)	-0.004	-0.001	0.006	0.008	0.001	0.004	0.017 (**)	-0.006	0.006	-0.002	-0.002	-0.011 (**)
LC	0.017	0.041 (**)	0.010	0.011 (*)	0.010	0.010	0.009	0.006	0.017 (**)	0.016 (**)	0.005	0.001	-0.001	-0.006 (**)
LH	0.021	0.066 (***)	-0.006	-0.007	0.010	0.008	0.007	-0.004	0.004	0.016 (**)	-0.001	-0.001	0.003	-0.014 (***)

Appendix A
(Continued)

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
PB	0.006	0.112 (***)	0.003	0.001	0.005	0.010	0.010	0.008	0.026 (***)	0.034 (***)	0.028 (***)	0.011 (*)	0	-0.011 (***)
Panel B: Price Shock 15%(-15%)														
A:Energy														
CO	0.059 (***)	0.047 (**)	0.015 (*)	0.021 (***)	0.002	0.001	-0.010	-0.010	0.021 (***)	0.029 (***)	0.027 (***)	0.027 (***)	-0.001	-0.004 (*)
HO	0.064 (***)	0.087 (***)	0.012 (*)	-0.006	0.001	-0.009	-0.010	-0.006	-0.008	0.021 (***)	0.023 (***)	0.015 (*)	0.003	-0.003 (*)
NG	0.061 (***)	0.078 (***)	0.030 (***)	-0.002	-0.010	-0.002	-0.007	-0.009	-0.010	0.005	0.002	0	0.025 (***)	-0.003 (*)
B:Metal														
G	-0.018	0.045 (**)	0.007	0.001	0	-0.002	0.021 (***)	-0.001	-0.001	-0.017 (**)	0.005	0	-0.002	-0.006 (**)
C	0.011	0.049 (**)	0.004	0.009	0.010	0.010	0.003	0.015 (*)	0.007	0	0	0.003	0.008	-0.008 (**)
S	0.005	0.071 (***)	0	0.001	0	-0.001	0.016 (**)	-0.004	0	-0.010	0	-0.001	-0.005	-0.008 (**)
P	0.021	0.086 (***)	0.001	0.003	-0.005	-0.004	-0.008	-0.006	-0.010	0.013 (*)	0.015 (*)	0.013 (*)	-0.007	-0.010 (**)
PL	-0.019	0.151 (***)	0.009	0.011 (*)	0.001	0	0.005	0.003	0.004	0.002	0.002	0.002	-0.001	-0.007 (**)
L	0.019	0.048 (***)	0.012 (**)	0	0	0	0.006	0.009	0.007	0.010	0.013 (*)	0.023 (***)	0	-0.011 (***)
C: Food (non-grains)														
CC	-0.024	-0.145 (**)	0.001	0.004	0.002	0.009	0.010	0.009	0.019 (**)	0.019 (**)	0	0	0.003	-0.011 (***)
CF	0.003	-0.046 (**)	-0.003	-0.003	-0.010	-0.010	-0.009	0	0.013 (*)	0.028 (***)	0.030**	-0.008	-0.004	-0.017 (***)
CT	0.001	0.023 (*)	0.003	0.001	0	0	0.004	0.018 (**)	0.015 (**)	0.025 (***)	-0.002	0.002	0.001	-0.012 (***)
OJ	0.012	0.081 (***)	0.010	0.008	0.006	0.008	0.004	0.004	0.002	0	-0.001	0.013 (*)	0.021 (***)	-0.011 (***)
SU	-0.024	0.073 (*)	0.021 (***)	0.004	0.002	0.007	0.004	0.009	0.010	0	0.021 (***)	0.006	-0.010	-0.014 (***)

Appendix A
(Continued)

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
CR	0.052 (***)	0.078 (***)	-0.005	0.002	0.009	0.008	0.005	0.010	0.003	-0.000	0.025 (***)	-0.001	0.004	-0.013 (***)
KW	0.026	0.046 (**)	0.010	0.011 (*)	0.014	0.002	0.025 (***)	0.024 (***)	0.023 (**)	0.035 (***)	0.009	0.010	0.009	-0.019 (***)
MW	0.010	0.152 (***)	0.007	0.004	0.009	0.008	0.037 (***)	0.056 (***)	0.044 (***)	0.032 (***)	0.009	0.009	0.010	-0.019 (***)
O	0.120 (***)	0.132 (***)	-0.006	0.011*	0.004	0.006	0.010	0.008	0.008	-0.001	0.050 (***)	0.074 (***)	0.129 (***)	-0.026 (***)
W	0.026	0.031 *	0.008	0.010	0.010	0.003	0.024 (***)	0.035 (***)	0.035 (**)	0.034 (***)	0.002	0.010	0.009	-0.011 (***)
SO	0.054 (***)	0.067 (***)	0.023 (***)	0.007	0.003	0.002	0.007	0.08	0.009	-0.003	-0.010	0.009	0.009	-0.015 (***)
SM	0.049 (**)	0.056 (***)	0.027 (***)	0.003	-0.004	0.002	-0.010	0.009	0.011 (*)	-0.007	-0.010	-0.010	-0.006	-0.011 (***)
SY	0.042 (**)	0.074 (***)	0.025 (***)	0.010	0.010	0.009	0.011 (*)	0.004	0.003	0.006	-0.005	0.010	0.005	-0.014 (***)
E:Livestock														
FC	0.062 (***)	0.087 (***)	0.002	-0.003	-0.004	0.007	-0.001	0.006	0.023 (***)	-0.007	0.003	-0.009	0	-0.015 (***)
LC	0.046 (**)	0.072 (***)	0.010	0.004	0.008	0.014 (*)	0.005	0.004	0.023 (***)	0.024 (***)	0.005	0	-0.003	-0.013 (***)
LH	0.026	0.072 (***)	0	-0.002	0.007	0.010	0.011 (*)	0.009	0.023 (***)	0.009	-0.016 (**)	-0.004	0.006	-0.014 (***)
PB	0.025	0.167 (***)	-0.001	0.002	-0.005	0.009	0	0.008	0.027 (***)	0.040 (***)	0.025 (***)	0.015 (**)	-0.005	-0.015 (***)

Panel C: Price Shock 2STD (-2STD)

A: Energy

CO	0.080 (***)	0.048 (**)	0.012 (*)	0.017 (**)	-0.010	-0.009	-0.006	-0.010	0.016 (**)	0.028 (***)	0.021 (***)	0.028 (***)	-0.002	-0.003 (*)
HO	0.086 (***)	0.032 (*)	0.011 (*)	0.009	-0.010	-0.007	-0.010	0.011 (*)	-0.006	0.014 (*)	0.016 (**)	-0.010	0.001	-0.009 (**)
NG	0.072 (***)	0.067 (***)	0.029 (***)	-0.002	-0.010	-0.008	-0.002	-0.008	-0.009	0.007	-0.002	-0.011	0.015 (*)	-0.004 (*)

Appendix A
(Continued)

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
G	0.056 (***)	0.043 (**)	0.004	-0.004	-0.004	-0.006	0.018 (**)	0	-0.005	-0.016 (**)	0.006	-0.008	0.005	-0.006 (**)
C	0.048 (**)	0.061 (***)	0.010	0	0.004	-0.006	0.005	0.011 (*)	-0.001	-0.006	-0.005	0.007	0.003	-0.006 (**)
S	0.048 (**)	0.072 (***)	0.004	-0.002	-0.006	-0.004	-0.013 (*)	-0.010	-0.007	-0.004	-0.009	-0.006	-0.010	-0.005 (*)
P	0.043 (**)	0.052 (***)	-0.002	-0.004	-0.010	-0.006	-0.010	-0.006	-0.009	-0.008	-0.009	-0.008	-0.002	-0.006 (**)
PL	0.040 (**)	0.092 (***)	0.010	0.006	0	0.006	0	0.003	0.001	-0.001	-0.004	0.032	0	-0.005 (*)
L	-0.024	0.046 (**)	-0.011 (*)	-0.001	-0.010	-0.005	-0.001	-0.010	-0.010	0	0.010 (*)	0.013*	0.015*	-0.015 (***)
C: Food (non-grains)														
CC	0.011	-0.056 (***)	0.006	0.007	0.010	0.009	0.010	0.002	0.016 (**)	0.015 (*)	-0.001	-0.003	0.0081	-0.017 (***)
CF	0.023	-0.057 (***)	0.004	0	0.001	-0.008	-0.002	0.011	0.015 (*)	0.03 (***)	0.015 (*)	-0.010	0.006	-0.014 (***)
CT	0.030 (*)	0.020 (*)	-0.001	-0.009	0.002	-0.006	0.001	0.017 (**)	0.018 (**)	0.018 (**)	-0.010	-0.010	-0.007	-0.015 (***)
OJ	0.043 (**)	-0.026 (*)	0.010	0.002	-0.008	-0.002	0.004	0.010	0.010	0.006	-0.001	0.021 (***)	0.015 (*)	-0.011 (***)
SU	0.044 (**)	0.020 (*)	0.021 (***)	-0.001	-0.009	0.003	-0.005	0.003	-0.001	-0.011	0.018 (**)	-0.009	-0.009	-0.011 (***)
D:Grains														
CR	0.026	0.043 (**)	0	0.002	-0.001	0.002	0.002	0.010	0.005	0.010	0.019 (**)	0	0	-0.015 (***)
KW	0.064 (***)	0.024 (*)	-0.002	0.002	-0.004	0.004	0.018 (**)	0.025 (***)	0.023 (***)	0.017 (**)	0.001	0	-0.005	-0.016 (***)
MW	0.079 (***)	0.059 (***)	0	-0.001	-0.007	0	0.024 (***)	0.031 (***)	0.034 (***)	0.018 (**)	0.002	0	-0.007	-0.020 (***)
O	0.131 (***)	0.059 (***)	-0.004	0.011 (*)	-0.003	0.003	0.005	0.008	0.01	0.003	0.048 (***)	0.049 (***)	0.032 (**)	-0.017 (***)
W	0.033 (*)	0.024 (*)	-0.002	0.001	0	0.001	0.015 (**)	0.023 (***)	0.011 (*)	0.019 (**)	0.002	-0.002	-0.004	-0.016 (**)

Appendix A (Continued)

Futures	intercept	open	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Ln Mat
SO	-0.012	0.056 (***)	0.012 (*)	0.002	0.001	-0.001	-0.003	0.001	0.002	0.009	-0.0018	-0.002	-0.001	-0.017 (***)
SM	0.010	0.043 (**)	0.019 (**)	-0.002	0.002	-0.001	0	0.004	0.010	0.008	0.003	0	0.002	-0.011 (***)
SY	0.011	0.045 (**)	0.017 (**)	0.004	0.008	0.004	0.004	0.009	0.002	0.010	0.006	0.004	0.002	-0.012 (***)
E:Livestock														
FC	-0.005	0.134 (*)	-0.002	-0.001	0.003	0	0.003	0.003	0.023 (***)	-0.002	0	-0.002	-0.002	-0.009 (**)
LC	-0.010	0.045 (**)	0.004	0	0.006	0.009	0.004	0.002	0.024 (***)	0.013 (*)	0.002	0.003	0	-0.008 (**)
LH	0.006	0.056 (***)	-0.002	-0.007	0.010	0.001	0.007	-0.004	0.010	0.019 (**)	0	0.001	-0.007	-0.012 (***)
PB	-0.011	0.054 (***)	0.004	0.001	0.005	0.010	0.008	0.009	0.013 (*)	0.017 (**)	0.011 (*)	0.013 (*)	-0.001	-0.017 (***)

Appendix B:

Probability of Reversal of Five Categories

The probability of reversal is defined as the number of reversal divided by the number of large price changes. This table presents the probability of reversal at the first day following large price changes in closing for five commodity categories.

Futures	5%	-5%	10%	-10%	15%	-15%	2STD	-2STD
Energy	51.019%	50.523%	49.176%	50.225%	50.611%	53.291%	50.414%	48.846%
Metal	45.803%	50.904%	49.962%	54.036%	43.650%	47.754%	49.555%	53.563%
Food (non-grains)	52.791%	52.302%	53.354%	54.428%	52.613%	58.077%	54.067%	57.180%
Grains	54.045%	52.723%	51.442%	56.146%	51.329%	54.197%	54.337%	51.424%
Livestock	52.593%	52.215%	49.388%	54.106%	48.373%	55.913%	53.769%	52.384%

Vita-Wei Hua

Wei Hua got her bachelor degree in Nanjing University of Technology in China between 2001 and 2005. She went to United Kingdom to get her Master degree in Banking and Finance in Loughborough Univeristy during the period 2005 to 2006. Now she finished her dissertation defense and will graduate in May, 2012, and get Ph. D in Financial Economics. Her research interests are in investment, financial markets, and corporate finance. Her dissertation focuses on international financial markets. In University of New Orleans, she taught four semesters in Micro, Macro, and financial markets. She also presented her paper" Cost and Efficiency of Credit Union" at the annual meeting of the Southwestern Finance Association in New Orleans in 2012.